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UCRL-SR-219259

Final Clean Closure Report Site 300 Surface Impoundments Closure Lawrence Livermore National Laboratory Livermore, California

K. Haskell

February 23, 2006

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FINAL
CLEAN CLOSURE REPORT
SITE 300 SURFACE IMPOUNDMENTS CLOSURE
LAWRENCE LIVERMORE NATIONAL LABORATORY
LIVERMORE, CALIFORNIA

Submitted to:

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TABLE OF CONTENTS

Tables

Figures

Appendices

CLEAN CLOSURE REPORT
SITE 300 SURFACE IMPOUNDMENTS CLOSURE

1.0 INTRODUCTION

Lawrence Livermore National Laboratory of the University of California (LLNL) operated two Class II surface impoundments that stored wastewater that was discharged from a number of buildings located on the Site 300 Facility (Site 300). The wastewater was the by-product of explosives processing. Reduction in the volume of water discharged from these buildings over the past several years significantly reduced the wastewater storage needs. In addition, the impoundments were constructed in 1984, and the high-density polyethylene (HDPE) geomembrane liners were nearing the end of their service life. The purpose of this project was to clean close the surface impoundments and provide new wastewater storage using above ground storage tanks at six locations. The tanks were installed and put into service prior to closure of the impoundments.

Golder Associates (Golder) prepared the Final Closure Plan (Closure Plan) for the site in February 2005 (Golder, 2005). The Closure Plan was submitted by LLNL to the Central Valley Regional Water Quality Control Board (CVRWQCB) for concurrence and approval on February 25, 2005, and Susan Timm of the CVRWQCB issued a concurrence with the submitted Closure Plan on May 9, 2005. A Notice to Proceed was issued on July 13, 2005. The work for the surface impoundment closure was initiated by LLNL on July 25, 2005, and the field work was completed on November 3, 2005. LLNL submitted a Notice of Completion to the CVRWQCB on November 21, 2005.

This Clean Closure Report (Closure Report) complies with State Water Resources Control Board (SWRCB) Section 21400 of the California Code of Regulations Title 27 (27 CCR §21400). As required by these regulations and guidance, this Closure Report provides the following information:

- A brief site description;
- The regulatory requirements relevant to clean closure of the impoundments;
- The closure procedures; and,
- The findings and documentation of clean closure.

This Closure Report was prepared on behalf of LLNL to document the completion of construction associated with the clean closure of the impoundments. LLNL staff managed and performed the closure project using subcontractors for the construction elements of the work and LLNL staff for construction observation and testing. Golder personnel were on-site to observe the construction and testing at critical points in the closure project. Specifically, Golder personnel were on-site once the clay liner was exposed in both the Upper and Lower Impoundments to visually inspect for obvious signs of leakage and to review and approve sampling locations and procedures. LLNL staff submitted the samples for verification sampling and analytical testing (see Sections 2.6 and 3.0) to a California certified analytical laboratory and reviewed and summarized the resulting data. Golder reviewed the analytical results and the data analyses performed by LLNL and have incorporated the data in this Closure Report.

1.1 Site Description and Project Background

A thorough discussion of the site's location, history, current operations, hydrogeology, and geology were provided in Golder's *Final Closure Plan* (Golder, 2005). This section provides a brief summary of the site and project background related to the subject impoundments.

Site 300 occupies 11 square miles in the Altamont Hills approximately 8.5 miles southwest of Tracy, California and 15 miles southeast of Livermore, California (as shown on Figure 1). In 1984, two

double-lined surface impoundments were installed near the explosives area (Figure 2). The surface impoundments were constructed with the following components from top to bottom:

- A 1-foot thick layer of sand ballast;
- A 60-mils thick high-density polyethylene (HDPE) geomembrane and geotextile;
- A layer of sand for the leachate collection and removal system (LCRS);
- A 2-foot thick compacted clay liner on the floor (4-foot thick on the side slopes); and,
- Soil subgrade.

Figure 3 shows a typical section of the liner. A leachate collection and removal system (LCRS) consisting of two-inch diameter slotted PVC pipes was installed at the base of the sand layer underlying the geomembrane. In addition, eight lysimeters (four in the Upper Impoundment and four in the Lower Impoundment) were installed for collection of fluid from below the clay liner. An experimental electrical resistivity leak detection system was also installed in the impoundment berms (i.e., a series of electrodes installed in traffic boxes).

Wastewater from the surface impoundments was tested in 1995 and 2003, and sludge was tested in 2002. A qualitative review of the data indicated:

- Soluble metals from the sludge were below reporting limits, except for Barium which was detected well below background levels in soil for Site 300;
- Total metals analyses indicated elevated levels of Chromium, Cobalt, Nickel and Vanadium (as compared with background soil screening values) were present in the sludge from the Lower Impoundment;
- Low level detections of dinitrotoluene compounds were observed in the sludge samples;
- No volatile or semi-volatile organic compounds were detected in wastewater;
- Both wastewater and sludge showed elevated levels of inorganic salts (as compared with values of wastewater flowing into the impoundments) associated with evaporation of water from the impoundments and concentration of the salts; and,
- Arsenic, Barium, Chromium, Copper, Lead, Potassium, Silver and Zinc were all consistently detected (i.e., in almost all analyses) in the dissolved state in the impoundment wastewater.

During the lifetime of the impoundment operations, several liner defects were identified and repaired. The defects, and known performance characteristics of similar impoundments, indicated the potential for leaks from the impoundments and possible contamination of the clay liner and subgrade soils.

In February 2005, Golder developed a closure plan to implement clean closure of the site in accordance with the requirements of 27 CCR §21400 and §21769.

1.2 Regulatory Requirements

Golder developed the Closure Plan that was implemented for the site following the closure requirements for Class II surface impoundments referenced in 27 CCR §21400 and §21769. These regulations specify:

- Removal of all free liquids remaining in the surface impoundments at the time of closure;
- Discharge of all free liquids at an appropriate waste management unit;
- Removal of all contaminated wastes, including sludges, precipitates, settled solids, and liner materials contaminated by waste;
- Discharge of all contaminated waste to an approved waste management unit;
- Inspection of all remaining containment features for contamination;
- Disposal of remaining containment features found to be contaminated, if any;
- Dismantling of remaining containment features that are found to be free of contamination;
- Removal of contaminated natural geologic materials surrounding the closed impoundments;
- Disposal of contaminated natural geologic materials at an appropriate waste management unit;
- Notification of the CVRWQCB 180 days prior to closure construction and within 30 days upon completion; and,
- Successful completion of clean-closure eliminates the need for Postclosure maintenance.

2.0 CLOSURE PROCEDURES

2.1 Decontamination Procedures

Equipment coming in contact with waste materials was decontaminated by dry cleaning prior to leaving the project containment area to prevent the spread of waste materials outside the containment area.

2.2 Liquid Evaporation

At the start of construction there was remaining liquid left in both the Upper and Lower Impoundments. The liquid in the Upper Impoundment was transferred to the Lower Impoundment to allow the demolition and closure activities to start. The liquid in the Lower Impoundment was mixed with soil excavated from the berms and off-hauled to the Altamont Landfill and Resource Recovery Facility (ALRRF) for proper disposal.

2.3 Demolition

Prior to start of grading, various appurtenant structures associated with the impoundments were demolished and removed, and disposed of at the ALRRF. Identified structures included, but were not necessarily limited to:

- Concrete stairs with galvanized steel railings;
- Lysimeter control boxes, valves, etc.;
- Traffic boxes (valves, electrical leak detection leads, etc.);
- Galvanized steel frame located in Upper Impoundment;
- Wooden stairs in Lower Impoundment; and,
- Concrete vault box for LCRS piping.

2.4 Sludge and Ballast Removal and Disposal

The sludge and sand ballast overlying the geomembrane were removed from within the impoundments and off-hauled to the ALRRF for proper disposal. Six composite grab samples and one duplicate sample were collected from the sludge and sand ballast prior to excavation to confirm the material would meet soil acceptance requirements at the ALRRF (Table 1A, Figure 4). The composite samples were submitted for appropriate analytical testing as specified by ALRRF. Required analyses included:

- Volatile Organics (USEPA Method 8260B);
- CAM 17 Metals, Total in Soil (USEPA Method 6010B);
- CAM 17 Metals, Soluble in Soil (USEPA Method 6010B);
- RDX/HMX (USEPA Method 8330).

Results from the testing are summarized in Table 2 and the Certified Analytical Reports are maintained by LLNL and are available upon request. The signed transmittal sheets from the analytical laboratory are provided in Appendix A. Procedures for sampling and the analytical testing program are discussed in more detail in the Sampling and Analysis Plan for the project (Appendix B).

2.5 Geomembrane/Geotextile and LCRS Removal and Disposal

Upon completion of the removal of the sludge and sand ballast, the HDPE geomembrane, underlying geotextile, and underlying sand and piping from the LCRS were removed. All materials were off-hauled to the ALRRF for proper disposal.

2.6 Clay Liner Verification Sampling and Testing

2.6.1 Clay Liner Background Sampling

Six samples and one duplicate sample of the clay liner were obtained from areas above the impoundment freeboard to develop background concentrations for the clay liner material (Table 1B, Figure 4). These samples were analyzed for the verification sampling parameters proposed in the Sampling and Analysis Plan (Appendix B). The monitoring parameters for the clean closure verification included:

- Barium, Total in Soil (USEPA Method 6010B);
- Chromium, Total in Soil (USEPA Method 6010B);
- Nickel, Total in Soil (USEPA Method 6010B);
- Zinc, Total in Soil (USEPA Method 6010B);
- Chloride, Total in Soil (USEPA Method 300.0);
- Sulfate, Total in Soil (USEPA Method 300.0); and,
- RDX/HMX (USEPA Method 8330).

Results from the background testing are summarized in Table 3. Copies of the signed transmittal sheets are provided in Appendix A. Complete data reports are maintained by LLNL and are available upon request. The background data was evaluated by LLNL staff using standard statistical methods (Standard Deviation and T-Statistic) and the Upper Confidence Limit (95% confidence, or 5% chance of exceedance) was determined for each detected parameter. The range of concentrations from existing background data for LLNL Site 300 soils are also presented in Table 3 for comparison.

2.6.2 Clay Liner Verification Sampling

The clay liner was inspected for visual evidence of contamination, and sampled and analyzed in general accordance with the Sampling and Analysis Plan (Appendix B) by LLNL staff. No obvious areas of staining were noted in either the Upper or Lower Impoundments. Sample locations and depths were in accordance with the proposed plan with the following exceptions:

- The Closure Plan identified that LLNL would analyze the successive depths of the clay in series and would only analyze for the soluble concentrations if the concentrations in the clay or soil exceeded the background concentrations. To avoid potential construction delays, all required samples were collected and analyzed in parallel (i.e., sample depths of 0 to 6 inches and 12 to 18 inches for both total and soluble parameters). Therefore, more data is presented for each location than actually called for by the approved Sampling and Analysis Plan (i.e., soluble data is presented at all locations even if the background concentrations were not exceeded).

- Location PL-4 was proposed for the side berm of the Upper Impoundment (Figure 4). Demolition activities required the removal of the embankment between the two impoundments in order to access the Lower Impoundment with heavy equipment. The berm (including the clay liner in the berm) was removed prior to sampling. Soil from the berm was mixed with the remaining liquids in the Lower Impoundment and off-hauled to the ALRRF for disposal. As a result, the PL-4 sample location was approximately 6 to 8 feet below the original clay liner elevation.

A total of 34 samples (including two duplicates) were collected from the clay liner in the Upper and Lower Impoundments and analyzed (Table 1C). Eleven of these samples (including one duplicate) were obtained from the clay liner near known areas of leakage in both the Upper and Lower Impoundments (Table 1C, Figure 4, PL-series samples). The remaining 23 clay liner samples were distributed to give aerial coverage of the clay liner in both impoundments (Table 1C, Figure 4, S-series samples). Seven samples (including one duplicate) were analyzed from the native soils underlying the liner in the PL locations and from location S-1 (Table 1C, Figure 4).

Results from the verification testing are discussed in Section 3.

2.7 Site Regrading

Once it was determined that all appropriate excavation and removal activities had been completed, and that the soils remaining in place met the clean closure criteria (discussed in Section 3.0), the site was regraded to remove the impoundment structures. The existing berms were excavated and the compacted backfill materials were utilized to fill in the former impoundment areas in a balanced cut and fill approach resulting in a relatively gentle, flat surface across the top of the ridge. The graded area drains to the east-southeast at an approximate grade of between two and six percent (Figure 5). The compacted backfill was placed under the observation of LLNL staff.

2.8 Hydroseeding

All disturbed areas of the clean closure site were revegetated with a seed mix developed by LLNL to best match native species. Revegetation was performed by hydroseeding with a mixture of seed, fertilizer, and mulch. Straw wattles were used to further protect against erosion.

3.0 CLEAN CLOSURE VERIFICATION RESULTS

3.1 Clean Closure Criteria

The Closure Plan outlined that clean closure would be considered complete if the verification samples from the clay liner have concentrations less than or equal to background concentrations from the clay liner background testing program and/or established site background concentrations for heavy metals in soil. Should concentrations from the samples collected from the upper portion of the clay liner exceed background concentrations, samples collected from the lower portion of the clay liner would be submitted for laboratory analyses. As discussed above, to avoid potential construction delays, all potentially required samples were collected and analyzed in parallel (i.e., sample depths of 0 to 6 inches and 12 to 18 inches for both total and soluble parameters). All sample locations discussed in this section are depicted on Figure 4.

The Closure Plan specified that the clay liner would be removed to the depth at which concentrations in the clay exceeded background concentrations. If exceedances of background for naturally occurring inorganics (i.e., metals) were observed in the subgrade materials then the Closure Plan specified that "The Designated Level Methodology" (DLM) (CVRWQCB, 1986) would be utilized to determine if water percolating through the subgrade soils would exceed the lowest water quality objective for each Constituent of Concern (COC). Based on the findings of the clay and soil sampling program, LLNL staff implemented the DLM to evaluate the potential threat to water quality associated with leaving the clay liner materials in place.

The following sections present the results from the verification testing program and describe the implementation and findings of the DLM evaluation.

3.2 Clay Liner Background Results

Table 3 presents the results from the clay liner background samples, the Site 300 background concentrations for total metals (determined from previous sampling), the upper 95% confidence limit (UCL 95%) determined from the clean closure sampling, analysis for total metals and total minerals, and the reporting limit for each constituent. Total barium concentrations ranged from 130 to 210 mg/kg. Total chromium concentrations ranged from 27 to 35 mg/kg. Total nickel and total zinc concentrations ranged from 21 to 31 mg/kg and from 42 to 53 mg/kg, respectively. All total metals concentrations were within the ranges of the Site 300 background concentrations previously measured for the respective constituents. All UCL 95% concentrations were also within the Site 300 background concentrations previously measured.

Total chloride concentrations ranged from 8.2 to 37 mg/kg. Total sulfate concentrations ranged from 15 to 50 mg/kg.

Total HMX and total RDX were all below the reporting limits of 0.5 mg/kg.

3.3 Upper Surface Impoundment Results (Total)

Table 4 presents the total metals, minerals, and energetic compounds results from the Upper Impoundment. The results are compared against: the UCL 95% for the clay liner background results, the range of concentrations from the clay liner background samples, the Site 300 background concentrations for total metals (determined from previous sampling).

Total barium concentrations ranged from 170 to 270 mg/kg. Total chromium concentrations ranged from 27 to 45 mg/kg. Total nickel concentrations ranged from 22 to 42 mg/kg. Total zinc concentrations ranged from 47 to 70 mg/kg, with the exception one sample (PL-2) that had a

concentration of 140 mg/kg. Note, however, that the soluble zinc concentration from this sample location was less than 0.01 mg/L, below the Soluble Designated Level of 20 mg/L. All total barium, total chromium, and total nickel concentrations were below the Site 300 background concentrations in soil (previously established values) and in the general range of the site specific background results. All total zinc concentrations were below the Site 300 background concentrations previously measured, with the exception of that from one sample (PL-2, native soil). The PL-2 sample collected from the native soil underlying the clay liner contained 140 mg/kg of total zinc, above the 78 mg/kg previously measured from background soil samples.

Total chloride concentrations ranged from 18 to 740 mg/kg. Total sulfate concentrations ranged from 28 to 1,200 mg/kg. Figures 6 and 7 show histograms for the total chloride and total sulfate concentrations from the samples, and compare the results to the UCL 95% and maximum background concentrations measured from the clay liner background samples. Figure 6 indicates that the samples collected from the shallow clay (0 to 6 inches below ground surface [bgs]) in the Upper Impoundment show elevated levels of chloride (i.e. above maximum background levels) in PL-1, PL-2, S-5, and S-6. Figure 6 also indicates that the deeper clay (12 to 18 inches bgs) in the Upper Impoundment locations PL-1, PL-3, S-1, S-2, S-4, and S-5 show elevated levels of chloride (above maximum background levels). The underlying native soil in the Upper Impoundment locations PL-1 and PL-3 also had elevated levels of chloride (above maximum background levels).

Figure 7 indicates elevated sulfate levels (above maximum background levels) in the shallow clay in the Upper Impoundment locations PL-1, PL-2, PL-3, S-1, S-4, and S-5 through S-7. Also shown in Figure 7 are elevated sulfate levels (above maximum background levels) in the deeper clay in the Upper Impoundment locations PL-1 through PL-4, S-1, S-5, and S-6 and in the native soils in locations PL-1, PL-2, and PL-4.

For sample locations in which chloride and/or sulfate were detected in the deeper clay and/or native soils, but not in the shallow clay (PL-3, for example), it is assumed that the chloride and sulfate has migrated from the shallow clay to the deeper clay/native soils.

Total HMX and RDX concentrations were below the reporting limits for all samples analyzed for total energetic compounds.

Section 3.5 discusses the Designated Level Methodology (DLM) developed by CVRWQCB staff to determine whether the constituents exceeding the background concentrations as presented above could cause degradation of the quality of the underlying ground water.

3.4 Lower Surface Impoundment Results (Total)

Table 5 presents the total metals, minerals, and energetic compounds results from the Lower Impoundment in comparison to the UCL 95% for the clay liner background results, the range of concentrations from the clay liner background samples, and the Site 300 background concentrations for total metals (determined from previous sampling).

Total barium concentrations ranged from 150 to 280 mg/kg. Total chromium concentrations ranged from 28 to 38 mg/kg. Total nickel and total zinc concentrations ranged from 30 to 37 mg/kg and from 48 to 59 mg/kg, respectively. All total metals concentrations were below the Site 300 background concentrations previously measured for the respective constituents and in the general range of the site specific background results.

Total chloride concentrations ranged from 31 to 170 mg/kg. Total sulfate concentrations ranged from 50 to 270 mg/kg. Figure 6 indicates that the samples collected from the Lower Impoundment's shallow clay (0 to 6 inches bgs) show elevated levels of chloride (i.e. above maximum background

levels) in PL-5, S-8, S-10, and S-11. Figure 6 also indicates that the Lower Impoundment's deeper clay (12 to 18 inches bgs) in locations PL-5 and S-8 through S-11 show elevated levels of chloride (above maximum background levels). The underlying native soil from Lower Impoundment locations PL-5 and S-11 also have elevated levels of chloride (above maximum background levels).

Figure 7 indicates elevated sulfate levels (above maximum background levels) in the shallow clay in Lower Impoundment locations PL-5, S-8, S-10, and S-11. Also shown in Figure 7 are elevated sulfate levels (above maximum background levels) in the deeper clay in Lower Impoundment locations PL-5 and S-8 through S-11 and in the native soils in locations PL-5 and S-11.

Total HMX and RDX concentrations were below the reporting limits for all samples analyzed for total energetic compounds.

Section 3.5 discusses the Designated Level Methodology (DLM) developed by CVRWQCB staff to determine whether the constituents exceeding the background concentrations as presented above could cause degradation of the quality of the underlying ground water.

3.5 Designated Level Methodology Evaluation

3.5.1 Methodology

The Designated Level Methodology (DLM) is a process developed by the CVRWQCB to determine whether concentrations of waste constituents could be mobilized and transported to ground waters and surface waters in amounts which could cause degradation of the quality of those waters; that is, cause them to exceed the applicable water quality goals. LLNL staff utilized the DLM for the clean closure of the surface impoundments to determine whether the constituents exceeding the background concentrations as presented above could cause degradation of the quality of the underlying ground water.

In the area of the Site 300 surface impoundments, the underlying ground water is considered the pertinent receiving water body. The lowest applicable water quality goals for these constituents were found in *A Compilation of Water Quality Goals* (August 2003), by the CVRWQCB. These goals included: California primary maximum contaminant levels (PMCLs) for barium, chromium, and nickel; California secondary maximum contaminant levels (SMCLs) for sulfate; California agricultural water quality goals for zinc and chloride; and U.S. Environmental Protection Agency suggested no-adverse-response-levels (SNARLs) for HMX and RDX.

Since only the soluble fraction of a waste constituent has the potential to migrate to ground water, the extractable concentration is the most accurate measure of a particular constituent that may degrade the ground water quality. The CVRWQCB recommends determining the extractable waste constituent concentrations using California's Waste Extraction Test (WET) procedure from Title 22 of the California Code of Regulations (CCR). The WET procedure requires a 10-fold dilution of waste into the extract solution, and normally uses a standard sodium citrate (acidic) buffer for extraction. However, de-ionized water may be used for extraction in the case where infiltrating non-acidic rainwater is expected to be the actual leaching solution, as is the case in the area of the surface impoundments.

Soluble Designated Levels represent concentrations of soluble or extractable constituents in a waste (represented by the concentration from the WET procedure) that threaten to degrade water quality if equaled or exceeded. Extractable constituents in a waste leaching to ground water may be attenuated by several factors including depth to ground water, clay content of the vadose zone, and many other factors. For simplicity, the CVRWQCB recommends using a "generic" environmental attenuation

factor of 100 for locations where the vadose zone is at least 30 feet thick, and contains significant and continuous clay or silty-clay layers.

For the LLNL analysis, depth to ground water ($Tnbs_2$) in the area of the surface impoundments is at least 70 feet for down gradient well W-817-04, and over 100 feet for wells W-817-01, W-817-02, and W-817-03. The vadose zone immediately beneath the clay liner of the surface impoundments consists of clays to silty clays, and other clays are present throughout the vadose zone. Therefore, an environmental attenuation factor of 100 is considered appropriate for this site. The equation for the Soluble Designated Level (SDL) is as follows:

SDL (mg/L) = Water Quality Goal (mg/L) X 100/10;

Where, the appropriate environmental attenuation factor is 100, and 10 is the factor for the 10-fold dilution employed in the WET procedure.

3.5.2 DLM Results

Tables 6 and 7 presents the soluble results for metals, minerals, and energetic compounds from the Upper and Lower Impoundments, respectively. The results are shown in comparison to the Water Quality Objective applicable to each constituent and the Soluble Designated Level (SDL) concentration assigned by the CVRWQCB (both discussed above).

Soluble concentrations for chloride and sulfate were generally in the range of 1.0 to 30 ppm with high values of 50 and 88 ppm, respectively, for location PL-1. The concentrations are approximately one to two orders of magnitude below the SDL's of 1,060 ppm and 2,500 ppm. Similarly, metals values were approximately one to two orders of magnitude below the SDL's with the exception of chromium which was typically lower than the SDL by a factor of 10 to 100. Soluble HMX and RDX concentrations were below the reporting limits for all samples analyzed for total energetic compounds with the exception of sample S-6 at 0.0075 mg/L just above the reporting limit of 0.005 mg/L.

In summary, the DLM analysis indicated that measured soluble concentrations of all constituents posed no threat to the underlying ground water quality. This information was presented to Susan Timm of the CVRWQCB who concurred with LLNL's conclusion and allowed the closure to proceed with no further excavation of clay or soil. (CVRWQCB, October 3, 2005.)

4.0 CONCLUSIONS AND RECOMMENDATIONS

Based on information provided by LLNL staff, and independent observations by Golder staff during critical phases of closure, we have developed the following conclusions and recommendations:

1. The clean closure project was performed in substantial conformance with the approved Closure Plan (Golder, 2005).
2. Analytical testing indicated that total concentrations of chloride and sulfate from samples of the clay liner and native soil exceeded those for liner background material and general Site 300 soil background concentrations. There was also a single location where zinc in native soil exceeded known background. While total concentrations exceeded the background concentrations established for the clay and soil, the soluble concentrations, based upon the DLM analysis indicated that the presence of these constituents at the detected concentrations posed no threat to the underlying ground water quality.
3. Given the above, it was determined that the remaining site soils (i.e., clay liner and native soils underlying the impoundments) could remain in place and that the site meets applicable requirements for clean closure (27 CCR §21400 and §CCR 21769).
4. It is recommended that the surface impoundment ground water monitoring program be terminated, and the WDR associated with the impoundments be rescinded, following review and approval of this Closure Report by the CVRWQCB.

5.0 REFERENCES

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State Water Resources Control Board, 1997. California Code of Regulations Title 27 Section 21769, Closure and Post-Closure Maintenance Plan Requirements. July 18, 1997.

TABLES

TABLE 1
SAMPLE LOCATION KEY
LLNL SITE 300 CLEAN CLOSURE REPORT

Table 1A. Sludge Sample Location Key

LLNL Field Location Designation	Analytical Sample Designation	Description
Location 001	MS-SIC-001-01-01-SC-1U	Four point composite sample collected within Upper Impoundment Grid I and II (see Figure 4)
Location 002	MS-SIC-002-02-01-SC-1U	Four point composite sample collected within Upper Impoundment Grid III and IV (see Figure 4)
Location 003	MS-SIC-003-03-01-SC-1U	Four point composite sample collected within Upper Impoundment Grid V and VI (see Figure 4)
Location 004	MS-SIC-004-04-01-SC-1U	Four point composite sample collected within Upper Impoundment Grid VII and VIII (see Figure 4)
Location 004 (dup)	MS-SIC-004-04-02-SD-1U	Duplicate of Location 004
Location 005	MS-SIC-005-05-01-SC-1U	Four point composite sample collected within Lower Impoundment Grid IX and X (see Figure 4)
Location 006	MS-SIC-006-06-01-SC-1U	Four point composite sample collected within Lower Impoundment Grid XI and XII (see Figure 4)

Table 1B. Background Sample Location Key

Closure Plan Location Designation	Analytical Sample Designation
B-1	MS-SIC-007-07-01-SO-1U
B-2	MS-SIC-008-08-01-SO-1U
B-3	MS-SIC-009-09-01-SO-1U
B-4	MS-SIC-010-10-01-SO-1U
B-5	MS-SIC-011-11-01-SO-1U
B-5 (duplicate)	MS-SIC-011-11-02-SD-1U
B-6	MS-SIC-012-12-01-SO-1U

TABLE 1, CONTINUED
SAMPLE LOCATION KEY
LLNL SITE 300 CLEAN CLOSURE REPORT

Table 1C. Upper and Lower Surface Impoundment Sample Location Key

Closure Plan Location Designation	Analytical Sample Designation	Sample Depth
Upper Surface Impoundment Sample Locations		
PL-1	MS-SIC-013-01-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-013-01-02-SO-1.5U	Clay liner, 12-18 inches
	MS-SIC-013-01-03-SO-2U	Native soil, below 2 ft
PL-2	MS-SIC-014-02-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-014-02-02-SO-1.5U	Clay liner, 12-18 inches
	MS-SIC-014-02-03-SO-2U	Native soil, below 2 ft
PL-3	MS-SIC-015-03-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-015-03-02-SO-1.5U	Clay liner, 12-18 inches
	MS-SIC-015-03-03-SO-2U	Native soil, below 2 ft
PL-4	MS-SIC-016-04-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-016-04-02-SO-1.5U	Clay liner, 12-18 inches
	MS-SIC-016-04-03-SO-2U	Native soil, below 2 ft
	MS-SIC-016-04-04-SD-2U	Native soil, duplicate
S-1	MS-SIC-017-05-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-017-05-02-SO-1.5U	Clay liner, 12-18 inches
S-2	MS-SIC-018-06-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-018-06-02-SO-1.5U	Clay liner, 12 – 18 inches
S-3	MS-SIC-019-07-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-019-07-02-SO-1.5U	Clay liner, 12-18 inches
S-4	MS-SIC-020-08-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-020-08-02-SO-1.5U	Clay liner, 12-18 inches
S-5	MS-SIC-021-09-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-021-09-02-SO-1.5U	Clay liner, 12-18 inches
S-6	MS-SIC-022-10-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-022-10-02-SO-1.5U	Clay liner, 12-18 inches
S-7	MS-SIC-023-11-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-023-11-02-SO-1.5U	Clay liner, 12-18 inches
	MS-SIC-023-11-03-SD-1.5U	Clay liner, 12-18 inches, dup
Lower Surface Impoundment Sample Locations		
PL-5	MS-SIC-024-01-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-024-01-02-SD-0.5U	Clay liner, 0-6 inches, dup
	MS-SIC-024-01-03-SO-1.5U	Clay liner, 12-18 inches
	MS-SIC-024-01-04-SO-2U	Native soil, below 2 ft
S-8	MS-SIC-025-02-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-025-02-02-SO-1.5U	Clay liner, 12-18 inches
S-9	MS-SIC-026-03-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-026-03-02-SO-1.5U	Clay liner, 12-18 inches
S-10	MS-SIC-027-04-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-027-04-02-SO-1.5U	Clay liner, 12-18 inches
S-11	MS-SIC-028-05-01-SO-0.5U	Clay liner, 0-6 inches
	MS-SIC-028-05-02-SO-1.5U	Clay liner, 12-18 inches
	MS-SIC-028-05-03-SO-2U	Native soil, below 2 ft

TABLE 2
SLUDGE AND SAND BALLAST CHEMISTRY
LLNL SITE 300 CLEAN CLOSURE REPORT

Constituent	Reporting Limit	LLNL's BSL[a]	USEPA's PRGs SSLs[b]	Location 001	Location 002	Location 003	Location 004[c]	Location 005	Location 006
Soluble Volatile Organics (mg/L) - EPA 8260[d]									
1,1,1-Trichloroethane	0.5	NA[e]	NA	< 0.5	< 0.5	< 0.5	< 0.5/< 0.5	< 0.5	< 0.5
Bromoform	0.5	NA	0.8	< 0.5	< 0.5	< 0.5	< 0.5/< 0.5	< 0.5	< 0.5
1,2-Dichloroethane	0.5	NA	NA	< 0.5	< 0.5	< 0.5	< 0.5/< 0.5	< 0.5	< 0.5
Freon 113	0.5	NA	NA	< 0.5	< 0.5	< 0.5	< 0.5/< 0.5	< 0.5	< 0.5
Methylene chloride[f]	1.0	NA	NA	190	190	180	170/370	370	360
Tetrachloroethene (PCE)	0.5	NA	NA	< 0.5	< 0.5	< 0.5	< 0.5/370	< 0.5	< 0.5
Chlorobenzene	0.5	NA	NA	< 0.5	< 0.5	< 0.5	< 0.5/< 0.5	< 0.5	< 0.5
Toluene[g]	0.5	NA	NA	< 0.5	< 0.5	< 0.5	< 0.5/0.15 est[h]	< 0.5	< 0.5
Naphthalene	0.5	NA	NA	< 0.5	< 0.5	< 0.5	< 0.5 /<0.5	< 0.5	< 0.5
Acetone[i]	10	NA	NA	56	360	82	73/74	68	82
Methyl ethyl ketone	20	NA	NA	< 20	< 20	< 20	< 20/<20	< 20	< 20
Ethanol	1000	NA	NA	< 1000	< 1000	< 1000	< 1000/<1000	< 1000	< 1000
Methyl isobutyl ketone	20	NA	NA	< 20	< 20	< 20	< 20/<20	< 20	< 20
Styrene	0.5	NA	NA	< 0.5	< 0.5	< 0.5	< 0.5/<0.5	< 0.5	< 0.5
Vinyl chloride	0.5	NA	NA	< 0.5	< 0.5	< 0.5	< 0.5/<0.5	< 0.5	< 0.5
Chloroform[j]	0.5	NA	NA	1.1	1.1	1.0	0.97/1.0	1.0	0.93
Carbon disulfide	1.0	NA	NA	< 1.0	1.0	7.4	1.8/1.3	1.6	2.8
Total Metals (mg/kg) - EPA 6010B									
Antimony	2.0	1	5.0	< 2.0	< 2.0	< 2.0	< 2.0/< 2.0	< 2.0	< 2.0
Arsenic	0.5	9.24	29	1.4	1.0	0.33 est	1.0/1.1	0.82	0.84
Barium	5.0	331	1,600	47	42	13	36/40	45	42
Beryllium	0.5	1.01	63	0.15 est	0.14 est	0.068 est	0.12 est/0.12 est	0.16 est	0.14 est
Cadmium	0.5	2.6	8.0	< 0.5	< 0.5	< 0.5	< 0.5/< 0.5	< 0.5	0.26 est
Chromium	5.0	45.6	38	8.7	6.9	1.4 est	5.3/5.1	7.1	5.5
Cobalt	2.5	16.2	NA	3.6	2.5	0.38 est	2.0 est/1.9 est	2.9	2.2 est
Copper	1.0	34	NA	5.2	6.8	5.1	6.3/5.3	5.4	5.8
Lead	2.5	70.3	NA	1.7	1.6 est	0.71 est	1.6 est/1.6 est	1.7	1.7
Mercury	0.12 - 0.16	0.05	NA	< 0.16	< 0.16	< 0.14	< 0.14/< 0.14	< 0.13	< 0.12
Molybdenum	2.5	12	NA	0.53 est	2.2 est	2.1 est	2.2 est/2.1 est	1.4 est	3.2
Nickel	10	66	130	9.6 est	5.2 est	1.3 est	3.9 est/3.8 est	5.5 est	4.3 est
Selenium	0.5	2.87	5.0	0.56	< 0.5	< 0.5	< 0.5/< 0.5	< 0.5	< 0.5
Silver	0.5	2.5	34	< 0.5	2.6	1.6	3.6/1.9	2.6	1.8
Thallium	5.0	1	NA	< 5.0	< 5.0	< 5.0	0.56 est/0.73 est	0.98 est	< 5.0
Vanadium	0.5	97.5	6,000	22	22	2.8	16/17	25	18
Zinc	5.0	78	12,000	23	26	12	22/20	21	21

TABLE 2
SLUDGE AND SAND BALLAST CHEMISTRY
LLNL SITE 300 CLEAN CLOSURE REPORT

Constituent	Reporting Limit	LLNL's BSL[a]	USEPA's PRGs SSLs[b]	Location 001	Location 002	Location 003	Location 004[c]	Location 005	Location 006
Soluble Metals (mg/L) - EPA 6010B									
Antimony	0.04	0.3	NA[e]	< 0.04	< 0.04	< 0.04	< 0.04/< 0.04	< 0.04	< 0.04
Arsenic	0.04	0.361	NA	0.035 est	< 0.04	< 0.04	< 0.04/< 0.04	< 0.04	< 0.04
Barium	5.0	18.9	NA	2.5 est	1.9 est	0.85 est	2.3est/2.3 est	1.9 est	2.0 est
Beryllium	0.004	0.05	NA	0.0042	0.002 est	< 0.004	0.0014 est/0.0014 est	0.0018 est	0.0012 est
Cadmium	0.004	0.1	NA	0.0016 est	< 0.004	< 0.004	0.0014 est/0.0018 est	0.00094 est	0.0019 est
Chromium	5.0	0.5	NA	< 5.0	< 5.0	< 5.0	< 5.0/< 5.0	< 5.0	< 5.0
Cobalt	5.0	1.51	NA	< 5.0	< 5.0	< 5.0	< 5.0/< 5.0	< 5.0	< 5.0
Copper	5.0	0.5	NA	< 5.0	< 5.0	< 5.0	< 5.0/< 5.0	< 5.0	< 5.0
Lead	5.0	1.18	NA	< 5.0	< 5.0	< 5.0	< 5.0/< 5.0	< 5.0	< 5.0
Mercury	0.16	0.005	NA	< 0.16	< 0.16	< 0.16	< 0.16/< 0.16	< 0.16	< 0.16
Molybdenum	5.0	0.5	NA	< 5.0	< 5.0	< 5.0	< 5.0/< 5.0	< 5.0	< 5.0
Nickel	5.0	1.11	NA	< 5.0	< 5.0	< 5.0	< 5.0/< 5.0	< 5.0	< 5.0
Selenium	0.04	0.05	NA	< 0.04	< 0.04	< 0.04	< 0.04/< 0.04	< 0.04	< 0.04
Silver	5.0	0.5	NA	< 5.0	< 5.0	< 5.0	< 5.0/< 5.0	< 5.0	< 5.0
Thallium	0.02	0.05	NA	< 0.02	0.0062 est	< 0.02	< 0.02/< 0.02	< 0.02	< 0.02
Vanadium	5.0	1.73	NA	0.25 est	< 5.0	< 5.0	0.22 est/0.21 est	0.19 est	0.18 est
Zinc	5.0	6.54	NA	< 5.0	< 5.0	< 5.0	< 5.0/< 5.0	< 5.0	< 5.0
Boron	5.0	NA	NA	1.4	5.2	7.0	3.9 est/3.3 est	5.5	7.9
Iron	5.0	NA	NA	100	61	12	86/95	77	70
Manganese	1.5	NA	NA	7.6	5.4	1.2 est	4.9/5.0	6.3	4.6
Energetic Compounds (mg/kg) - EPA 8330									
HMX	0.5	NA	3,100/31,000[k]	< 0.5	< 0.5	< 0.5	< 0.5/< 0.5	< 0.5	< 0.5
RDX	0.5	NA	4.4/16[k]	< 0.5	1.4	1.2	2.8/5.4	2.2	4.8

[a] LLNL's Background Screening Levels (established S300 soil background concentrations).

[b] USEPA's Preliminary Remediation Goals Soil Screening Levels for migration to ground water - attenuation factor of 20.

[c] Routine and duplicate results presented

[d] Analyses by BC Labs; no other volatile organic compounds were detected in the TCLP extract using EPA Method 8260.

[e] NA - Not applicable

[f] Methylene chloride was detected in the method blank sample at 647 µg/L.

[g] Toluene was detected in the method blank sample at 0.24 µg/L.

[h] Results followed by an "est" have estimated concentrations between the method detection limit and the reporting limit

[i] Acetone was detected in the method blank sample at 50 µg/L.

[j] Chloroform was detected in the method blank sample at 0.71 µg/L.

[k] USEPA's Preliminary Remediation Goals for residential/industrial exposure to soils for HMX and RDX

TABLE 3
CLAY LINER BACKGROUND RESULTS
LLNL SITE 300 CLEAN CLOSURE REPORT

	Site 300 Site-Specific Background[a]	UCL 95%[b]	Reporting Limit	B-1	B-2	B-3	B-4	B-5[c]	B-6
Total Metals (mg/kg) - EPA 6010B									
Barium	0 - 331	253	5.0	190	210	170	180	200/180	130
Chromium (total)	0 - 45.6	37	5.0	30	35	27	28	30/27	27
Nickel	0 - 66	36	10	28	31	28	27	28/27	21
Zinc	0 - 78	58	5.0	49	53	42	47	50/45	48
Total Minerals (mg/kg) - EPA 300.0									
Chloride	NA[d]	53	5.0	37	32	8.2	25	11/9.2	8.5
Sulfate	NA	77	10	45	48	17	50	16/15	45
Energetic Compounds (mg/kg) - EPA 8330									
HMX	0	NA	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5/< 0.5	< 0.5
RDX	0	NA	0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5/< 0.5	< 0.5

[a] Previously determined Site 300 background concentrations for total metals.
[b] Statistical upper 95% confidence limit determined from these results alone.
[c] Routine and duplicate results presented.
[d] Not applicable

TABLE 4
UPPER SURFACE IMPOUNDMENT RESULTS (TOTAL)
LLNL SITE 300 CLEAN CLOSURE REPORT

	UCL 95%[a] in Clay	Range of Bkgd Conc in Clay	LLNL BSL[g]	RL[b]	PL-1			PL-2			PL-3			PL-4		
					0-6 in	12-18 in	Native Soil	0-6 in	12-18 in	Native Soil	0-6 in	12-18 in	Native Soil	0-6 in	12-18 in	Native Soil[c]
Total Metals (mg/kg) - EPA 6010B																
Barium	253	130 - 210	331	1.0	180	220	270	210	210	180	190	200	180	190	210	270/270
Chromium (total)	37	27 - 35	45.6	1.0	33	30	29	36	31	27	33	30	27	33	33	35/31
Nickel	36	21 - 31	66	20	32	30	37	33	30	28	32	31	22	34	31	33/30
Zinc	58	42 - 53	78	10	51	47	51	53	49	140[d]	50	50	50	50	53	61/55
Total Minerals (mg/kg) - EPA 300.0																
Chloride	53	8.2 - 37	NAV[e]	5.0	740	190	140	59	22	18	49	43	32	23	19	21/22
Sulfate	78	15 - 50	NAV	10	1,200	340	240	120	58	54	90	46	41	52	52	85/92
Energetic Compounds (mg/kg) - EPA 8300																
HMX	< 0.5	<0.5	NA[f]	0.5	< 0.5	< 0.66	< 0.5	< 0.5	< 0.56	< 0.5	< 0.59	< 0.45	< 0.5	< 0.5	< 0.5	< 0.5/< 0.72
RDX	< 0.5	<0.5	NA	0.5	< 0.5	< 0.66	< 0.5	< 0.5	< 0.56	< 0.5	< 0.59	< 0.45	< 0.5	< 0.5	< 0.5	< 0.5/< 0.72

	S-1		S-2		S-3		S-4		S-5		S-6		S-7	
	0-6 in	12-18 in	0-6 in	12-18 in	0-6 in	12-18 in	0-6 in	12-18 in	0-6 in	12-18 in	0-6 in	12-18 in	0-6 in	12-18 in[c]
Total Metals (mg/kg) - EPA 6010B														
Barium	220	190	170	230	210	210	220	190	180	230	210	230	230	250/250
Chromium (total)	32	33	32	35	37	35	34	35	36	39	37	45	35	40/39
Nickel	31	31	28	34	34	34	36	33	32	37	34	42	33	38/36
Zinc	50	53	55	55	57	54	54	54	54	63	57	70	55	64/61
Total Minerals (mg/kg) - EPA 300.0														
Chloride	34	63	34	39	30	20	34	44	56	47	40	37	29	31/32
Sulfate	61	55	47	41	34	28	59	42	150	84	85	81	56	46/47
Energetic Compounds (mg/kg) - EPA 8330														
HMX	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5/< 0.5
RDX	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5/< 0.5

[a] Statistical upper 95% confidence limit determined from 6 clay liner background samples.
[b] Analytical Reporting Limit
[c] Routine and duplicate data presented.
[d] Soluble zinc concentation from this sample location was <0.01 mg/L, below the Soluble Designated Level of 20 mg/L
[e] Not available
[f] Not applicable
[g] LLNL's Background Screening Levels (established S300 soil background concentration)

TABLE 5
LOWER SURFACE IMPOUNDMENT RESULTS (TOTAL)
LLNL SITE 300 CLEAN CLOSURE REPORT

	UCL 95%[a] in Clay	Range of Bkgd Conc in Clay	LLNL BSL[f]	RL[b]	PL-5			S-8	
					0-6 in[c]	12-18 in	Native Soil	0-6 in	12-18 in
Total Metals (mg/kg) - EPA 6010B									
Barium	253	130 - 210	331	1.0	190/210	210	150	190	200
Chromium (total)	37	27 - 35	45.6	1.0	36/32	35	32	34	35
Nickel	36	21 - 31	66	20	35/32	34	37	32	35
Zinc	58	42 - 53	78	10	53/50	54	59	48	58
Total Minerals (mg/kg) - EPA 300.0									
Chloride	53	8.2 - 37	NAV[d]	5.0	150/170	110	98	42	45
Sulfate	78	15 - 50	NAV	10	260/270	110	67	60	81
Energetic Compounds (mg/kg) - EPA 8330									
HMX	< 0.5	<0.5	NA[e]	0.5	< 0.5/< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
RDX	< 0.5	<0.5	NA	0.5	< 0.5/< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

	S-9		S-10		S-11		
	0-6 in	12-18 in	0-6 in	12-18 in	0-6 in	12-18 in	Native Soil
Total Metals (mg/kg) - EPA 6010B							
Barium	200	200	280	200	220	220	230
Chromium (total)	35	31	33	34	38	36	28
Nickel	34	30	31	34	35	35	31
Zinc	53	50	52	52	57	57	58
Total Minerals (mg/kg) - EPA 300.0							
Chloride	31	40	130	93	140	100	100
Sulfate	50	54	190	93	230	98	100
Energetic Compounds (mg/kg) - EPA 8330							
HMX	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
RDX	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5

[a] Statistical upper 95% confidence limit determined from 6 clay liner background samples.
[b] Analytical Reporting Limit
[c] Routine and duplicate data presented.
[d] Not available
[e] Not applicable
[f] LLNL's Background Screening Levels (established S300 soil background concentration)

TABLE 6
UPPER SURFACE IMPOUNDMENT RESULTS (SOLUBLE)
LLNL SITE 300 CLEAN CLOSURE REPORT

	Water Quality Objective	SDL[a] Conc	RL[b]	PL-1			PL-2			PL-3			PL-4		
				0-6 in	12-18 in	Native Soil	0-6 in	12-18 in	Native Soil	0-6 in	12-18 in	Native Soil	0-6 in	12-18 in	Native Soil[c]
Soluble Metals (mg/L) - EPA 6010B															
Barium	1.0[d]	10	0.01	0.037	0.044	0.11	0.12	0.047	0.023	0.12	0.051	0.032	0.17	0.19	0.20/0.054
Chromium (total)	0.05[d]	0.5	0.01	0.001 est[e]	0.0007 est	0.058	0.056	0.012	< 0.01	0.0007 est	0.0015 est	< 0.01	0.0033 est	0.0037 est	< 0.01/0.0016 est
Nickel	0.1[d]	1	0.01	0.0024 est	0.0021 est	0.0067 est	0.05	0.034	0.0014 est	0.007 est	0.0033 est	0.0014 est	0.0061 est	0.0032 est	0.0011 est/0.0026 est
Zinc	2.0[f]	20	0.01	0.0031 est	0.006 est	0.0084 est	0.13	0.12	0.0026 est	0.0075 est	0.0075 est	0.0043 est	0.018	0.036	0.011/0.0066 est
Soluble Minerals (mg/L) - EPA 300.0															
Chloride	106[f]	1060	0.5	50	22	8	14	2.5	2.5	5.3	4.2	3.7	2.4	2.1	2/2.2
Sulfate	250[g]	2500	1	88	42	40	23	6.9	7.7	13	4.6	7.2	5.5	13	15/12
Energetic Compounds (mg/L) - EPA 8330															
HMX	0.4[h]	4	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005/< 0.005
RDX	0.0003[h]	0.003	0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005/< 0.005

	S-1		S-2		S-3		S-4		S-5		S-6		S-7	
	0-6 in	12-18 in	0-6 in	12-18 in	0-6 in	12-18 in	0-6 in	12-18 in	0-6 in	12-18 in	0-6 in	12-18 in	0-6 in	12-18 in[c]
Soluble Metals (mg/L) - EPA 6010B														
Barium	0.03	0.058	0.17	0.32	0.039	0.11	0.076	0.058	0.05	0.22	0.027	0.071	0.066	0.025/0.018
Chromium (total)	0.0017 est	0.0029 est	0.0016 est	0.0026 est	0.038	0.0012 est	0.0014 est	0.0018 est	0.017	0.0024 est	< 0.01	0.0015 est	0.004 est	0.002 est/< 0.01
Nickel	0.0025 est	0.0043 est	0.0039 est	0.0062 est	0.0047 est	0.0063 est	0.0032 est	0.0037 est	0.0026 est	0.0052 est	0.0024 est	0.0027 est	0.0067 est	0.0033 est/0.0023 est
Zinc	0.0077 est	0.01	0.012	0.019	0.014	0.014	0.0096 est	0.015	0.007 est	0.024	0.0041 est	0.014	0.01	0.0089 est/0.013
Soluble Minerals (mg/L) - EPA 300.0														
Chloride	3.9	4.8	3.9	3.5	4.6	2.1	2.7	3	7.4	5.5	5.7	4.1	2.6	3.4/3.7
Sulfate	8.6	4.9	5.7	3.4	7.1	3.3	5.4	4.9	24	9.1	13	9.6	6.5	4.9/5.1
Energetic Compounds (mg/L) - EPA 8330														
HMX	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	0.0075	< 0.005	< 0.005/< 0.005
RDX	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005/< 0.005

[a] CVRWQCB's Soluble Designated Level (SDL) concentration
[b] Analytical Reporting Limit
[c] Routine and duplicate data presented.
[d] California Primary Maximum Contaminant Level (PMCL).
[e] Results followed by an "est" have estimated concentrations between the Method Detection Limit and the Reporting Limit for each analyte.
[f] California agricultural water quality goal.
[g] California Secondary Maximum Contaminant Level (SMCL).
[h] USEPA suggested no-adverse-response-level (SNARL).

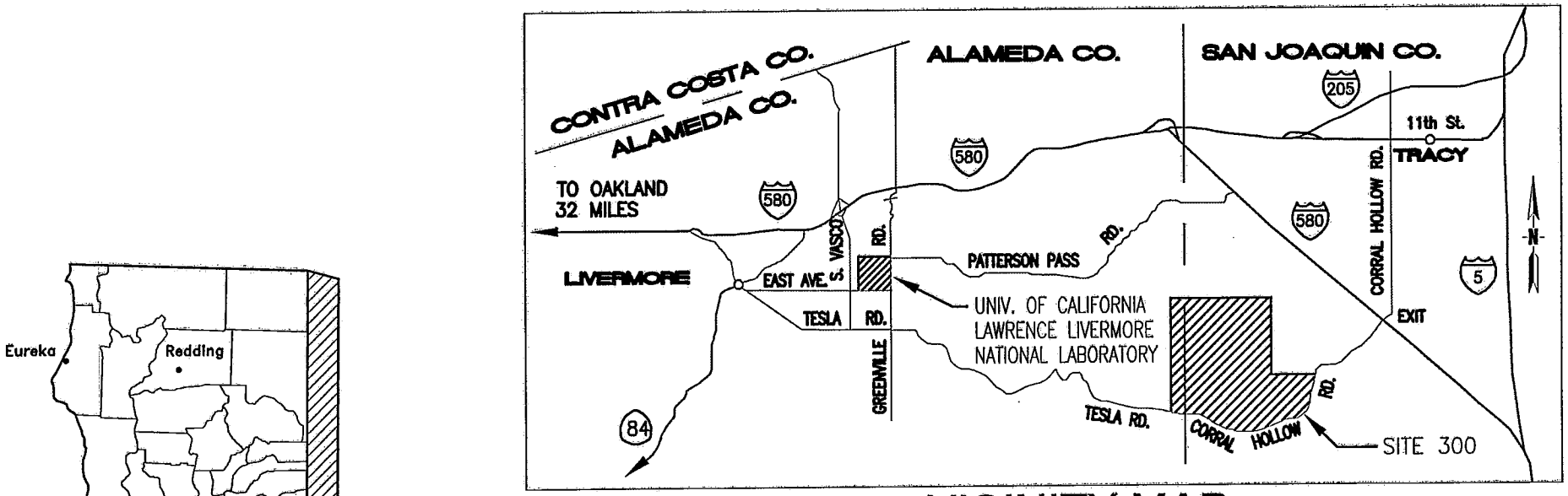
TABLE 7
LOWER SURFACE IMPOUNDMENT RESULTS (SOLUBLE)
LLNL SITE 300 CLEAN CLOSURE REPORT

	Water Quality Objective	SDL[a] Conc	RL[b]	PL-5			S-8	
				0-6 in[c]	12-18 in	Native Soil	0-6 in	12-18 in
Soluble Metals (mg/L) - EPA 6010B								
Barium	1.0[d]	10	0.01	0.012/0.0095 est[e]	0.0096 est	0.031	0.0091 est	0.013
Chromium (total)	0.05[d]	0.5	0.01	0.0013 est/0.0011 est	< 0.01	< 0.01	0.0044 est	0.001 est
Nickel	0.1[d]	1	0.01	0.0022 est/0.003 est	< 0.01	< 0.01	0.0048 est	< 0.01
Zinc	2.0[f]	20	0.01	0.0051 est/0.0071 est	0.0027 est	0.0082 est	0.0042 est	0.0038 est
Soluble Minerals (mg/L) - EPA 300.0								
Chloride	106[f]	1060	0.5	16/18	11	9.7	4.8	4.3
Sulfate	250[g]	2500	1	32/33	13	9.9	7.9	8.8
Energetic Compounds (mg/L) - EPA 8330								
HMX	0.4[h]	4	0.005	< 0.005/< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
RDX	0.0003[h]	0.003	0.005	< 0.005/< 0.005	< 0.005	< 0.005	< 0.005	< 0.005

	S-9		S-10		S-11			
	0-6 in	12-18 in	0-6 in	12-18 in	0-6 in	12-18 in	Native Soil	
Soluble Metals (mg/L) - EPA 6010B								
Barium	0.065	0.02	0.023	0.047	0.18	0.13	0.027	
Chromium (total)	0.0025 est	0.0021 est	0.0013 est	0.0029 est	0.003 est	0.0024 est	0.0009 est	
Nickel	0.0035 est	0.003 est	0.0036 est	0.0049 est	0.0045 est	0.0042 est	< 0.01	
Zinc	0.012	0.014	0.0038 est	0.0071 est	0.0088 est	0.029	0.0093 est	
Soluble Minerals (mg/L) - EPA 300.0								
Chloride	3.4	3.7	14	7.9	15	11	10	
Sulfate	6.7	7.3	25	10	31	12	15	
Energetic Compounds (mg/L) - EPA 8330								
HMX	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	
RDX	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	

[a] CVRWQCB's Soluble Designated Level (SDL) concentration
[b] Analytical Reporting Limit
[c] Routine and duplicate data presented.
[d] California Primary Maximum Contaminant Level (PMCL).
[e] Results followed by an "est" have estimated concentrations between the Method Detection Limit and the Reporting Limit for each analyte.
[f] California agricultural water quality goal.
[g] California Secondary Maximum Contaminant Level (SMCL).
[h] USEPA suggested no-adverse-response-level (SNARL).

FIGURES



VICINITY MAP

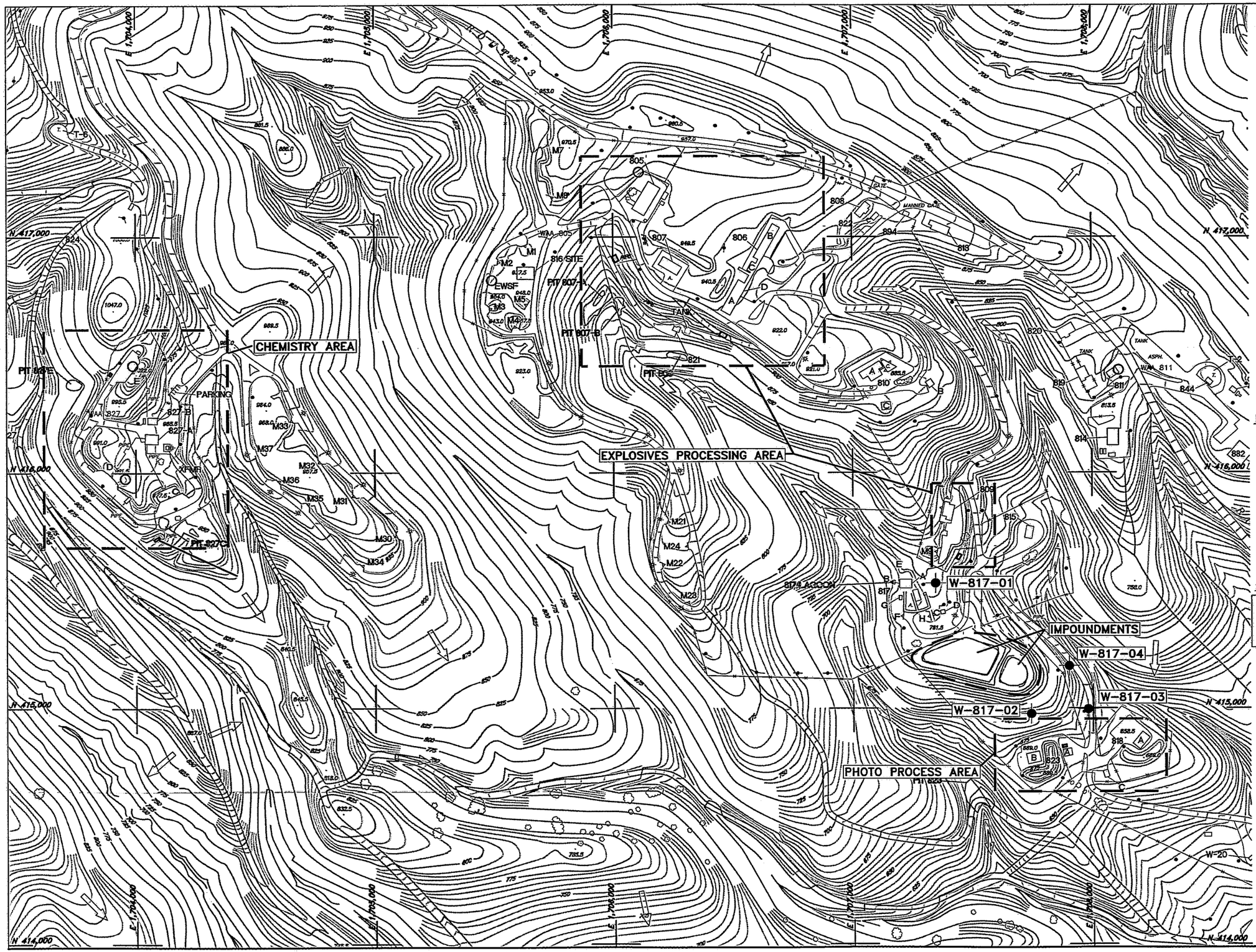
NOT TO SCALE

LOCATION MAP

FIGURE 1

SITE LOCATION MAP

LLNL/SITE 300 CLEAN CLOSURE REPORT/CA



NOTES:

1) TOPOGRAPHIC CONTOURS PREPARED USING AERIAL PHOTOGRAMMETRIC METHODS. LOCAL TOPOGRAPHIC CONTOURS IN IMPOUNDMENTS PREPARED USING GROUND SURVEY METHODS BY LLNL SURVEYORS. DATE OF SURVEY: SEPTEMBER 2004.

LEGEND:

W-817-03	APPROX. MONITORING WELL LOCATION AND ID

FIGURE **2**

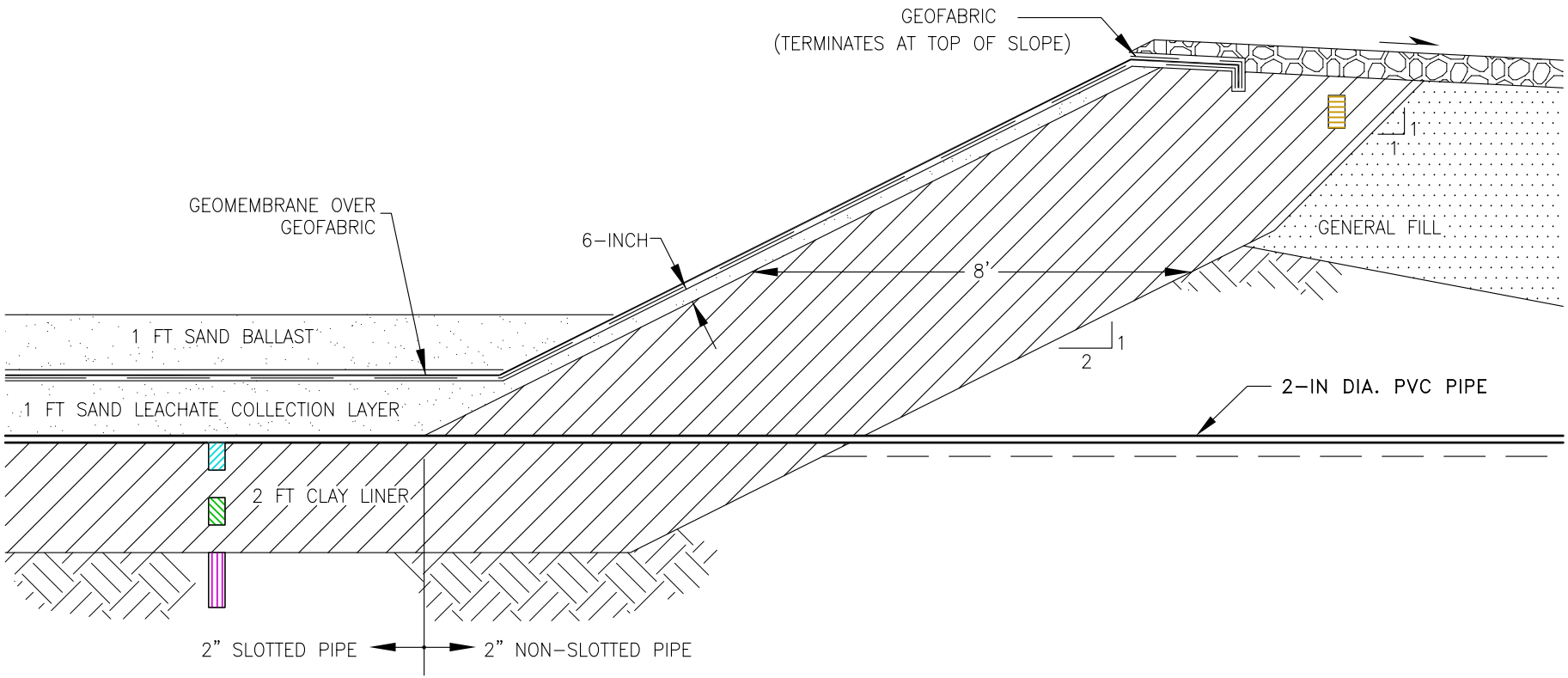
SITE PLAN

LLNL/SITE 300

CLEAN CLOSURE REPORT/CA

Golder Associates

DWG ID: JRaub | N:\Projects\053-7446 (LLNL-Constr Support)\Clean Closure Report\Dwgs\Fig 2 - Site Plan.dwg | 2-1-6 11:36 | xrf: PSZ2004-0300-0002D_0007D



TYPICAL LINER SECTION SCHEMATIC

NOT TO SCALE

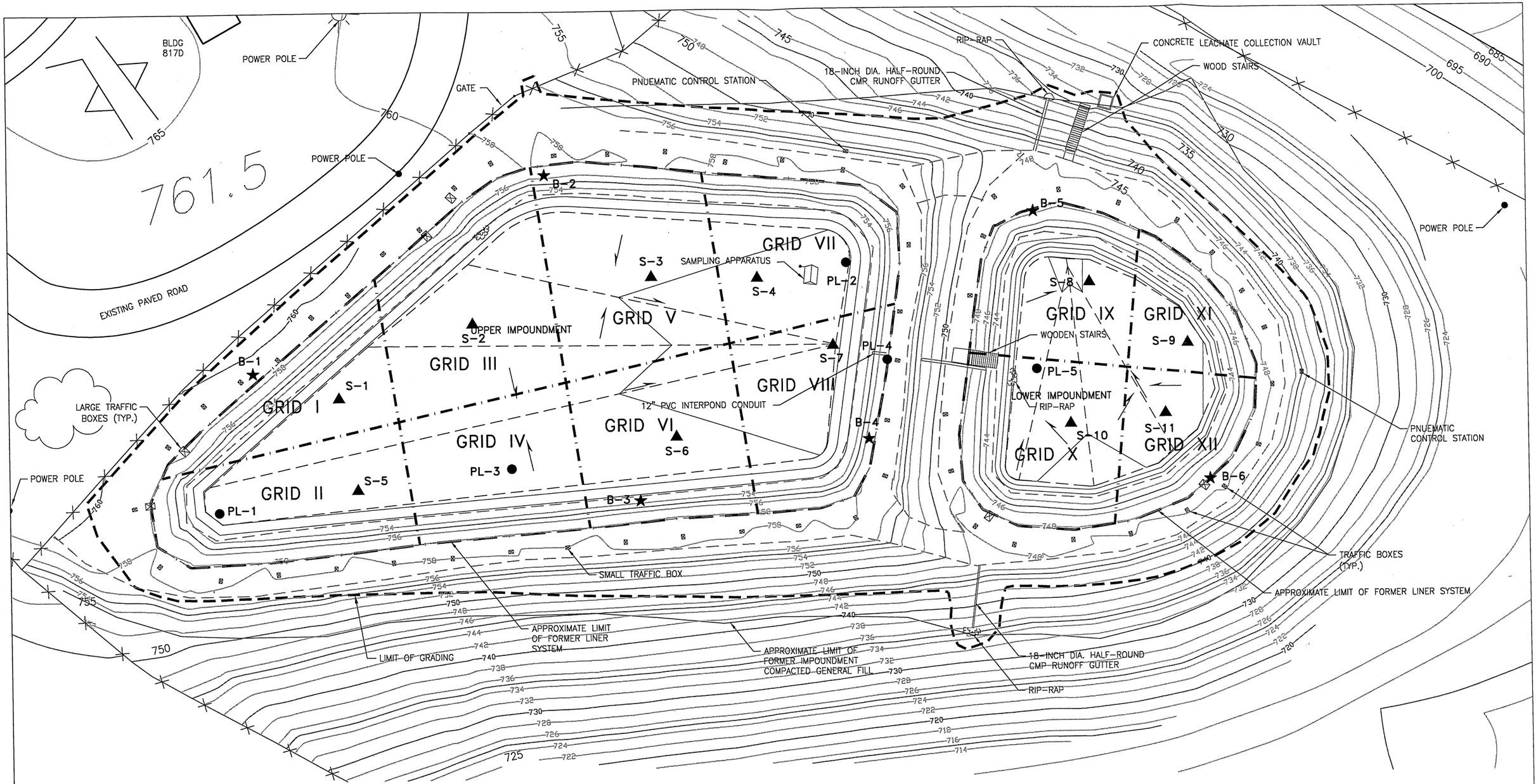
LEGEND:

- 0-6" CLAY SAMPLE
- 12-18" CLAY SAMPLE
- 0-12" SUBGRADE SAMPLE
- BACKGROUND SAMPLE

FIGURE **3**

LINER SECTION SCHEMATIC

LLNL/SITE 300 CLEAN CLOSURE REPORT/CA



LEGEND:

S-1	▲	APPROXIMATE CLAY & SUBGRADE SAMPLE LOCATION
B-1	★	APPROXIMATE BACKGROUND SAMPLE LOCATION
PL-1	●	APPROXIMATE SAMPLE LOCATION OF PREVIOUS LEAK
GRID I		GRID NUMBER DESIGNATED FOR COMPOSITE SLUDGE SAMPLES
	— · — · —	GRID BOUNDARY DESIGNATED FOR COMPOSITE SLUDGE SAMPLES

NOTES:

1) TOPOGRAPHIC CONTOURS PREPARED USING GROUND SURVEY METHODS BY LLNL SURVEYORS. DATE OF SURVEY: SEPTEMBER 2004. TOPOGRAPHY SHOWN IS MODIFIED TO SHOW APPROXIMATE TOP-OF-CLAY LINER GRADES IN THE BOTTOM OF THE IMPOUNDMENTS.

0 40 80
FEET

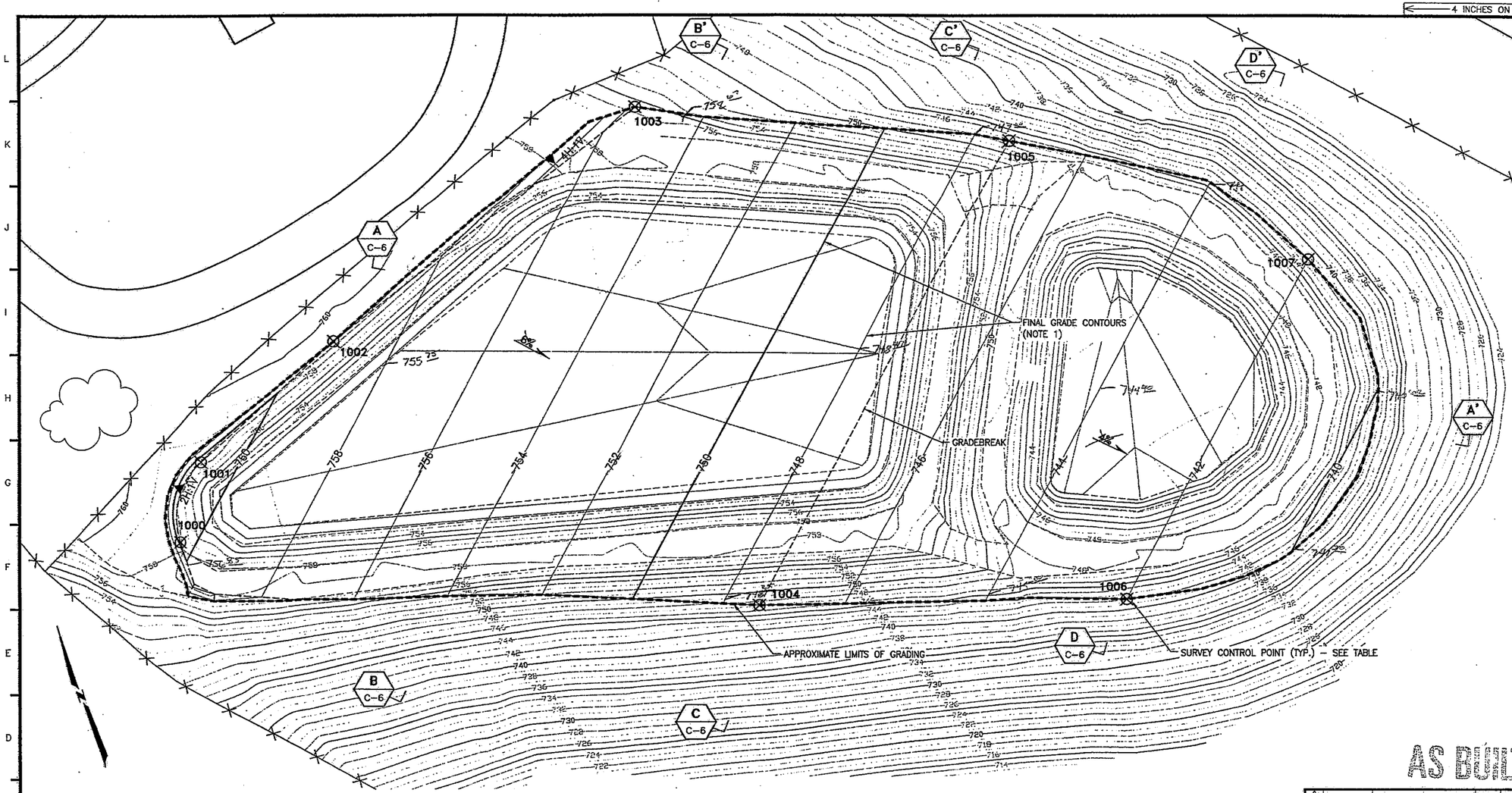
FIGURE **4**

IMPOUNDMENT PLAN AND SAMPLING LOCATIONS

LLNL/SITE 300 CLEAN CLOSURE REPORT/CA

Golder Associates

DWG ID: jraub | N:\Projects\053-7446 (LLNL-Constr Support)\Clean Closure Report\Dwgs\Fig 4 - Existing Impoundments.dwg | 12-15-5 16:10 | xrf: PSZ2004-0300-0002D_0007D



AS BUILT

NOTES:

1) IT IS THE INTENT OF THE GRADING PLAN TO PROVIDE A BALANCED CUT AND FILL. THE FINAL GRADE ELEVATIONS MAY BE INCREASED OR DECREASED BY UP TO ONE FOOT VERTICALLY TO ACHIEVE THIS BALANCE. HOWEVER, THE FINAL SURFACE GRADES MUST BE MAINTAINED WITHIN 0.5% FROM THE DESIGN GRADES SHOWN. POSITIVE DRAINAGE MUST BE MAINTAINED AT ALL LOCATIONS. NO PONDING OR REVERSED GRADES ARE ALLOWED.

2) TOPOGRAPHIC CONTOURS PREPARED USING GROUND SURVEY METHODS BY LLNL SURVEYORS. DATE OF SURVEY: SEPTEMBER 2004.

CONTROL POINT TABLE

POINT NO.	NORTHING FT.	EASTING FT.	ELEV. FT.	DESCRIPTOR
1000	415210.54	1707279.92	760.36	E CORNER @ SLOPE HINGE, POINT OF CURVATURE
1001	415239.30	1707298.42	760.84	E CORNER @ SLOPE HINGE, POINT OF TANGENCY
1002	415269.37	1707364.65	759.38	NW EDGE @ CUT/FILL TRANSITION POINT
1003	415322.52	1707511.11	755.60	N CORNER @ 4H:1V SLOPE TOE
1004	415111.77	1707493.56	747.21	GRADEBREAK @ SW EDGE
1005	415261.90	1707649.93	747.21	GRADEBREAK @ NE EDGE
1006	415067.50	1707635.40	742.00	DAYLIGHT POINT @ SW EDGE
1007	415176.89	1707749.34	742.00	DAYLIGHT POINT @ NE EDGE

REGISTERED PROFESSIONAL ENGINEER
KENNETH G. HUNTER
No. C53290
CIVIL
STATE OF CALIFORNIA
PE Stamp

No.	Date	Revision	Dwn	Chk	D/C	PM	CL

Golder Associates
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Suite 350
Roseville, CA 95678
Tel: (916) 786-2424
Fax: (916) 786-2434

Lawrence Livermore National Laboratory
Plant Engineering, Livermore, CA 94550

SURFACE IMPOUNDMENTS CLOSURE
LLNL - SITE 300

FINAL CLOSURE
GRADING PLAN

Des: PEB	1/14/05	Scale: 1" = 20'
Dwn: JDR	1/14/05	PFNID: FIRP04001
Chk: KGH	1/14/05	S/W: AUTOCAD 2004
Dwg. No. PSZ2004-0300-0005D		Sht. No. C-4 5 of 10

File Name: N:\Projects\053-7408 (LLNL-Site 300 closure)\Dwgs\Title II\Ponds\Final\PSZ2004-0300-0002D_0007D.dwg Date Plotted: January 17, 2005 – 5:13pm

FIGURE 5
AS-BUILT GRADING PLAN
LLNL/SITE 300 CLEAN CLOSURE REPORT/CA

DWG ID: JRaub | N:\Projects\053-7446 (LLNL-Constr Support)\Clean Closure Report\Dwgs\Fig 5 – As-built Grading Plan.dwg | 2-1-6 10:34 | xrf: NONE

Golder Associates

FIGURE 6
CHLORIDE HISTOGRAM

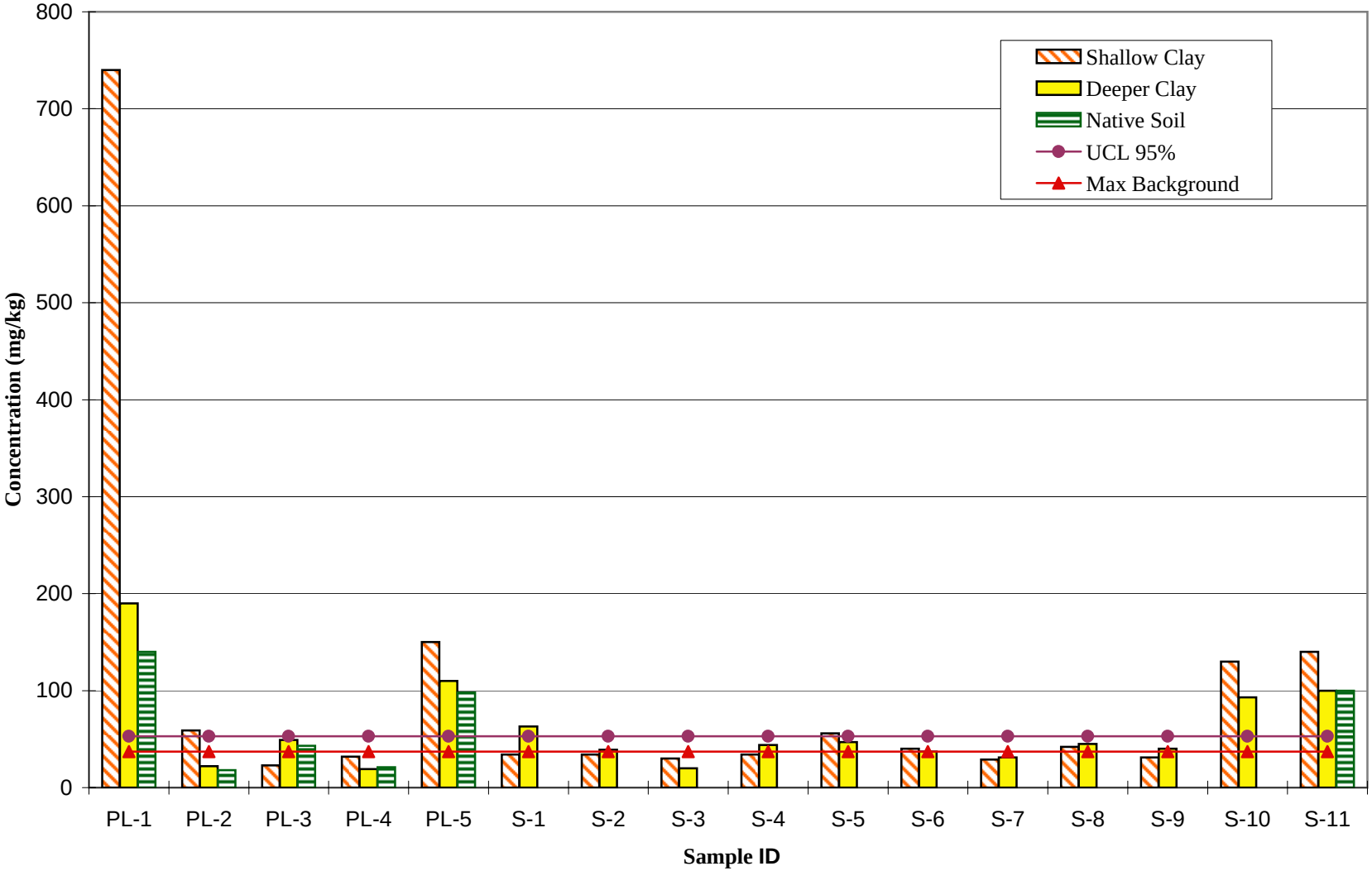
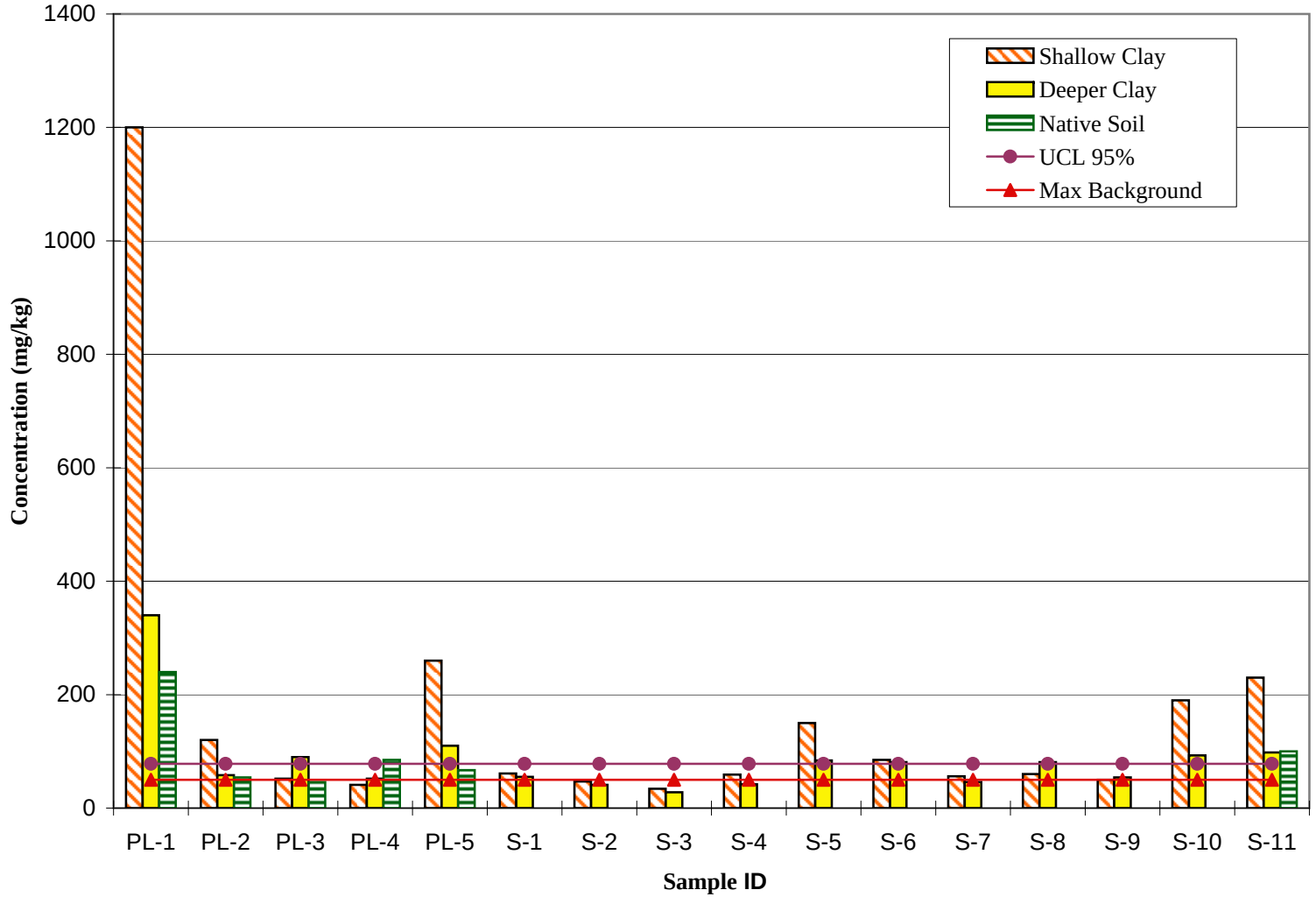


FIGURE 7
SULFATE HISTOGRAM



APPENDIX A

CERTIFIED ANALYTICAL REPORTS

TRANSMITTAL SHEETS

BC Laboratories, Inc.

Date of Report: 10/03/2005

Richard Brown
Lawrence Livermore National Laboratory
P.O. Box 808, L629
Livermore, CA 94551
RE: EOG
BC Lab Number: 0509175

Enclosed are the results of analyses for samples received by the laboratory on 09/16/05 14:39. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Contact Person: Christina Herndon
Client Service Rep

Authorized Signature

4100 Atlas Court • Bakersfield, CA 93308 • (661) 327-4911 • FAX (661) 327-1918 • www.bclabs.com

BC Laboratories, Inc

Date of Report: 07/25/2005

Richard Brown
Lawrence Livermore National Laboratory
P.O. Box 808, L629
Livermore, CA 94551
RE: EOG
BC Lab Number: 0506839

Enclosed are the results of analyses for samples received by the laboratory on 07/13/05 16:01. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Contact Person: Christina Herndon
Client Service Rep

Authorized Signature

BC Laboratories, Inc

Date of Report: 07/25/2005

Richard Brown
Lawrence Livermore National Laboratory
P.O. Box 808, L629
Livermore, CA 94551
RE: EOG
BC Lab Number: 0506840

Enclosed are the results of analyses for samples received by the laboratory on 07/13/05 13:41. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Contact Person: Christina Herndon
Client Service Rep

Authorized Signature

BC Laboratories, Inc

Date of Report: 09/15/2005

Richard Brown
Lawrence Livermore National Laboratory
P.O. Box 808, L629
Livermore, CA 94551
RE: EOG
BC Lab Number: 0508738

Enclosed are the results of analyses for samples received by the laboratory on 09/02/05 09:57. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Contact Person: Christina Herndon
Client Service Rep

Authorized Signature

4100 Atlas Court • Bakersfield, CA 93308 • (661) 327-4911 • FAX (661) 327-1918 • www.bclabs.com

APPENDIX B

SAMPLING AND ANALYSIS PLAN

SAMPLING AND ANALYSIS PLAN
SITE 300 SURFACE IMPOUNDMENTS CLOSURE
LAWRENCE LIVERMORE NATIONAL LABORATORY
LIVERMORE, CALIFORNIA
UCRL-SR-206943

Submitted to:

Lawrence Livermore National Laboratory
7000 East Avenue
L-654 P.O. Box 808
Livermore, CA 94551

Submitted by:

Golder Associates Inc.
1009 Enterprise Way
Suite 350
Roseville, California 95678

Distribution:

(2) Copies LLNL
(1) Copy Golder Associates Inc.

February 2005

Project No. 043-7408

SAMPLING AND ANALYSIS PLAN
SITE 300 SURFACE IMPOUNDMENTS CLOSURE
LAWRENCE LIVERMORE NATIONAL LABORATORY
LIVERMORE, CALIFORNIA
UCRL-SR-206943

Submitted to:

Lawrence Livermore National Laboratory
7000 East Avenue
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Livermore, CA 94551

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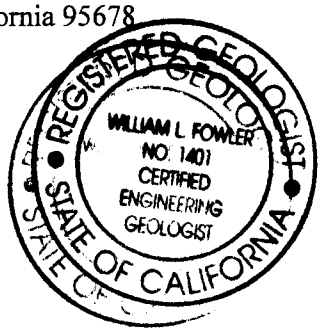
Roseville, California 95678



Golder Associates Inc.

Maureen A. Mathias	William L. Fowler, C.E.G.	Kenneth Haskell, P.E.
Project Engineer	Senior Consultant	Senior Consultant

February 2005

043-7408

SAMPLING AND ANALYSIS PLAN
SITE 300 SURFACE IMPOUNDMENTS CLOSURE

TABLE OF CONTENTS

Section **Page**

Tables

Figures

SAMPLING AND ANALYSIS PLAN
SITE 300 SURFACE IMPOUNDMENTS CLOSURE

1.0 INTRODUCTION

The field methods and procedures described in this Sampling and Analysis Plan (S&A Plan) are general descriptions of environmental sampling protocols. The methods described are intended for sampling and analysis relevant to clean closure of the Site 300 Surface Impoundments located at the University of California's Lawrence Livermore National Laboratory. The results will be used to 1) determine appropriate disposal of excavated materials and, 2) to determine if the clay liner and underlying soils meet acceptable criteria for clean closure.

Sampling will be performed on materials collected from three different media associated with the closure project:

- Sampling of the sludge and sand ballast overlying the impoundment geomembrane;
- Sampling of the clay liner underlying the LCRS; and,
- Sampling of soils underlying the clay liner.

The sludge, ballast sand, and LCRS sand will be excavated and disposed of at an appropriate waste management unit. Results from the sludge/ballast sampling event will be used to characterize the LCRS. The recommended testing protocols are intended for soil disposal characterization. It is assumed based on previous testing results that these materials will meet criteria for disposal at a Class II landfill (Altamont Landfill).

The second sampling and analysis event will be on the clay liner and underlying soils to satisfy regulatory criteria for clean closure of the surface impoundments. The excavation subcontractor will provide a backhoe and operator to work with the LLNL sampling technologist to excavate test locations. The LLNL sampling technologist will obtain the samples and submit for analyses per the protocol established herein. Material from the clay liner may be incorporated in the general fill for final grading, depending on the sampling results.

2.0 SAMPLING LOCATIONS AND FREQUENCY

2.1 Sludge/Ballast Sampling

It is anticipated that approximately 240 cubic yards (cy) of sludge will be removed from within the impoundments, along with approximately 1,050 cy of sand ballast that lies on top of the geomembrane. Based on the estimated volume above, six (6) composite grab samples will be collected from the sludge and sand ballast (i.e., approximately four composite samples for every 750 cy). Assuming four (4) samples will be collected for each composite sample this is a total of 24 discrete samples. Sixteen (16) grab samples will be obtained from the upper pond, and eight (8) samples will be obtained from the lower pond; four (4) composite samples and two (2) composite samples will be prepared for analytical testing, respectively. The Subcontractor will need to allow time in the construction schedule for analytical testing and authorization for disposal prior to excavation of the sludge and/or ballast.

Sample locations will be determined in the field and will be spaced at approximately equal intervals throughout the floor of the impoundment. Sample locations will be documented on a field map.

2.2 Clay Liner Sampling

Samples will be collected from the clay layer underlying the impoundments and submitted for laboratory analysis to investigate whether leaks through the geomembrane have contaminated the clay. Samples for verification of clean closure will be collected from:

- Known leak locations;
- Areas observed to be contaminated based on visual inspection; and
- Specified locations across the clay liner.

There are six documented areas where liner defects were previously discovered and repaired by LLNL (see Section 2.1.3.1 of the Closure Plan for discussion). Two leaks occurred in approximately the same location within the western corner of the upper impoundment. Figure B-1 shows the five general areas of the leaks that will be visually inspected and sampled. In addition, other areas with visual evidence of contamination (soil discoloration, staining, etc.) will also be sampled and submitted for laboratory analysis as discussed in Section 4.0 of this S&A Plan. Finally, general areas will also be sampled following the grid layout shown on Figure B-1.

In summary, it is anticipated that a minimum of eleven samples will be collected from the clay liner within the upper impoundment, and a minimum of five (5) samples will be collected from the lower impoundment. Five samples are located in areas of suspected leakage (four in the upper impoundment and one in the lower), and the remaining eleven (11) samples are distributed to provide areal coverage of the base of the liner. Additional samples may be collected at the discretion of field personnel based on visual evidence of leakage. This sampling plan will result in approximately 15 sample locations per acre.

Two (2) samples will be collected from each sample location within the clay liner, one at 0-to 6-inches within the clay liner, and one at 12-to 18-inches within the liner. The deeper samples will be analyzed if results from the shallower samples indicate that the clay has been contaminated.

Six (6) background samples for the clay will be collected from the clay liner at locations around the top of the impoundments above the high wastewater elevation (Figure B-1 and B-2). Four (4) background samples will be collected from the upper impoundment and two (2) samples will be collected from the lower impoundment. These samples will be analyzed for the verification sampling parameters using the test methods presented in Section 4.0. The results from these samples will serve as background data for comparing the indicator sample data and determining if leakage through the geomembrane has occurred. Background sampling will be conducted prior to the start of clean closure activities.

2.3 Subsurface Soils Sampling

Six (6) samples will be collected from the soils underlying the clay to determine if contaminants have leached through the liner; four (4) from the upper impoundment and two (2) from the lower impoundment. The samples will be collected from 0- to 12-inches below the bottom of the clay liner. Deeper sampling may be required if evidence of contamination is encountered (see Section 4.6.3 of Final Closure Plan for discussion). These samples will be analyzed for the clean closure monitoring parameters using the test methods presented in Section 4.0 of this S&A Plan.

3.0 SAMPLE COLLECTION AND HANDLING PROCEDURES

All sampling activities will be conducted by LLNL personnel using LLNL procedures (SOP EO-03, Collecting Samples). Sludge and ballast materials will be collected by LLNL field personnel using a shovel, scoop, auger, or other suitable device. The bulk samples will be composited and transferred to an appropriate container. Each container will be labeled and logged on an appropriate chain-of-custody form. Approximately 500 grams of materials will be prepared for each composite sample. Sample locations will be documented on a field map. All field equipment in contact with the sample media will be decontaminated between each sample location.

A backhoe will be used to excavate test pits from which the clay liner and native subgrade samples will be collected. Bulk samples will be retrieved from materials excavated from each depth interval using a clean stainless steel scoop, auger or other suitable device, composited, and transferred to an appropriate container. Each container will be labeled and logged on an appropriate chain-of-custody form. Approximately 500 grams of sample media will be prepared for each composite. Sample locations will be documented on a field map. All field equipment in contact with sample media will be decontaminated between each sample location.

Samples will be maintained in a cooler at 4 degrees C, and submitted to a certified analytical laboratory at the end of each work day following standard chain of custody protocol. The samples will be kept in a dark location due to potentially photo-sensitive materials.

4.0 SAMPLE ANALYSIS

4.1 Clean Closure Verification Analyses

Clean closure indicator parameters for the clay liner and underlying soils consist of a select list of "indicator parameters" from the existing discharge wastewater monitoring program currently required by the Waste Discharge Requirements (WDR) 96-248 (See Closure Plan Section 4.6.1). The list of indicator monitoring parameters recommended for the clean closure activities consist of:

- Barium, Total in Soil (USEPA Method 6010B);
- Chromium, Total in Soil (USEPA Method 6010B);
- Nickel, Total in Soil (USEPA Method 6010B);
- Zinc, Total in Soil (USEPA Method 6010B);
- Chloride, Total in Soil (USEPA Method 300.0);
- Sulfate, Total in Soil (USEPA Method 300.0); and,
- RDX/HMX (USEPA Method 8330).

The parameters, methods, and reporting limits are provided in Table 1 (attached). Quality assurance/quality control samples will consist of duplicates as specified by LLNL personnel.

4.2 Clean Closure Contingency Sampling and Analysis

If exceedances of background for the above listed parameters are observed in native soils underneath the liner, then additional testing for soluble constituents (STLC) will be performed to determine if there is a potential threat to groundwater (Table 2, attached). Only those parameters with exceedances over background will require further testing. The Designated Level Methodology (DLM) (CRWQCB, 1986) will be utilized to determine if water percolating through the subgrade soils will exceed the lowest water quality objective for each of the heavy metals listed above. The Designated Level Methodology entails determining extractable waste constituent concentrations using the California Waste Extraction Test (WET) procedure (Title 22, CCR, §66700). For this application, it is recommended that the extraction be performed using de-ionized water since the future source water for any percolation through the native soils is naturally occurring rainfall. Although there is no background concentration for RDX and HMX, the DLM would also be performed for RDX and HMX to determine the threat to groundwater quality if they were detected.

4.3 Soil Disposal Analyses

A full suite of analyses was previously performed by LLNL on sludge from the upper and lower impoundments (Table 2, Final Closure Plan). One sample was collected from each impoundment and a duplicate sample was also collected for the upper impoundment. This data showed the sludge to be non-hazardous.

The impoundment waste materials will be considered "special waste" by landfill disposal facilities and will require a "Generator Waste Profile" along with appropriate analytical backup. The generator must certify that the materials are non-hazardous per 22CCR §66260, and must also provide representative analyses based on the nature of the waste.

For off-site disposal associated with this project, the sludge/sand ballast samples will be analyzed for:

- STLC CAM 17 Metals (USEPA 6000/7000 series);
- Total CAM 17 Metals (USEPA 6000/7000 series);
- TCLP ZERO Extraction (USEPA method 8021); and,
- High Explosives (USEPA method 8330).

The impoundment waste materials will be considered "special waste" by landfill disposal facilities and will require a "Generator Waste Profile" along with appropriate analytical backup. The generator must certify that the materials are non-hazardous per 22CCR §66260, and must also provide representative analyses based on the nature of the waste.

It is recommended that the Generator Waste Profile, existing backup analytical data, and proposed analytical sampling frequency and analytical methods be presented for pre-approval to the selected waste facility at least two weeks prior to the start of the construction phase of the project. Once pre-approval has been obtained, the above off-site disposal analyses data verifying the non-hazardous nature of the soils should be submitted to the selected waste disposal facility for approval prior to transport of the soils to the facility. For this project, the Altamont Class II Landfill has been identified as the selected waste disposal facility.

TABLES

TABLE 1
CLAY AND SOIL SAMPLING AND ANALYSIS
Total Constituents

	LLNL's Parameter Code	Preparation Method	Analysis Method	Reporting Limit (mg/kg)	Site-Specific Background (mg/kg)
Total Metals (TTLC)					
Barium	0475	3050B[a]	EPA 6010B	5-10	tbd[b]
Chromium (total)	2450	3050B[a]	EPA 6010B	5-10	tbd
Nickel	5850	3050B[a]	EPA 6010B	10	tbd
Zinc	9050	3050B[a]	EPA 6010B	5-10	tbd
Total Minerals					
Chloride	1950	EPA-approved method	EPA 300.0	5	tbd
Sulfate	8025	EPA-approved method	EPA 300.0	5	tbd
Energetic Compounds					
HMX	4935	EPA-approved method	EPA 8330	0.2	na
RDX	7125	EPA-approved method	EPA 8330	0.2	na

TTLC = Total Threshold Limit Concentration

[a] or approved EPA Method

[b] tbd = To be determined from site-specific clay "background" samples

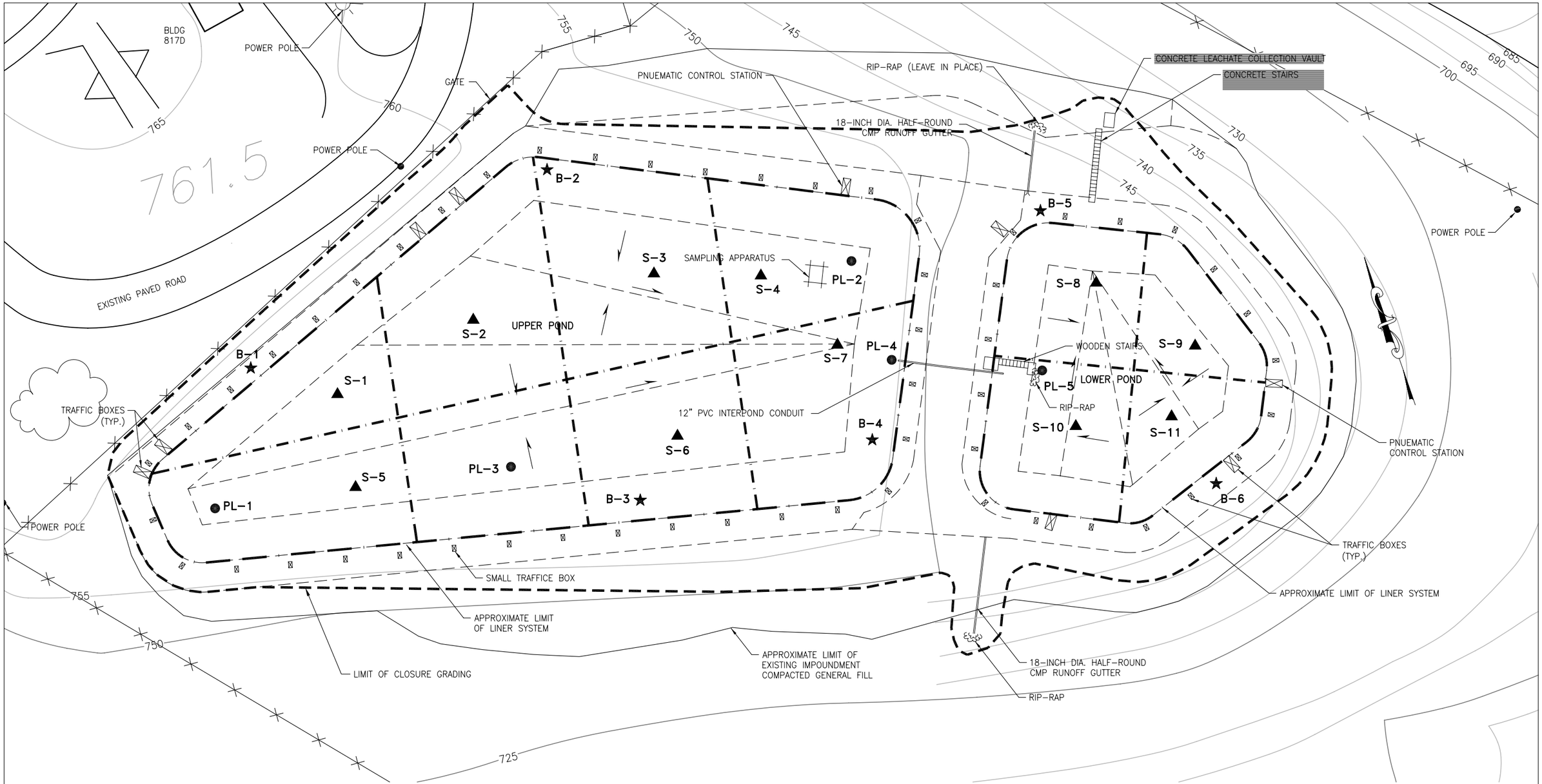
TABLE 2
CLAY AND SOIL SAMPLING AND ANALYSIS
Soluable Constituents

	LLNL's Parameter Code	Leaching Method	Analysis Method	Reporting Limit (mg/L)
Soluable Metals (STLC)				
Barium	0475	CA WET[a]	EPA 6010B or 6020	0.5-1.0
Chromium (total)	2450	CA WET	EPA 6010B or 6022	0.5
Nickel	5850	CA WET	EPA 6010B or 6024	0.5-1.0
Zinc	9050	CA WET	EPA 6010B or 6026	1.0
Soluable Minerals				
Chloride	1950	CA WET	EPA 300.0	5-10
Sulfate	8025	CA WET	EPA 300.0	5-10
Soluable Energetic Compounds				
HMX	4935	CA WET	EPA 8330	0.005-0.01
RDX	7125	CA WET	EPA 8330	0.005-0.01

STLC = Soluble Threshold Limit Concentration

[a] California Waste Extraction Test (leached with deionized water)

FIGURES



LEGEND:

S-1	▲	PROPOSED CLAY & SUBGRADE SAMPLE LOCATION
B-1	★	PROPOSED BACKGROUND SAMPLE LOCATION
PL-1	●	APPROXIMATE SAMPLE LOCATION OF PREVIOUS LEAK

0 400 800
FEET

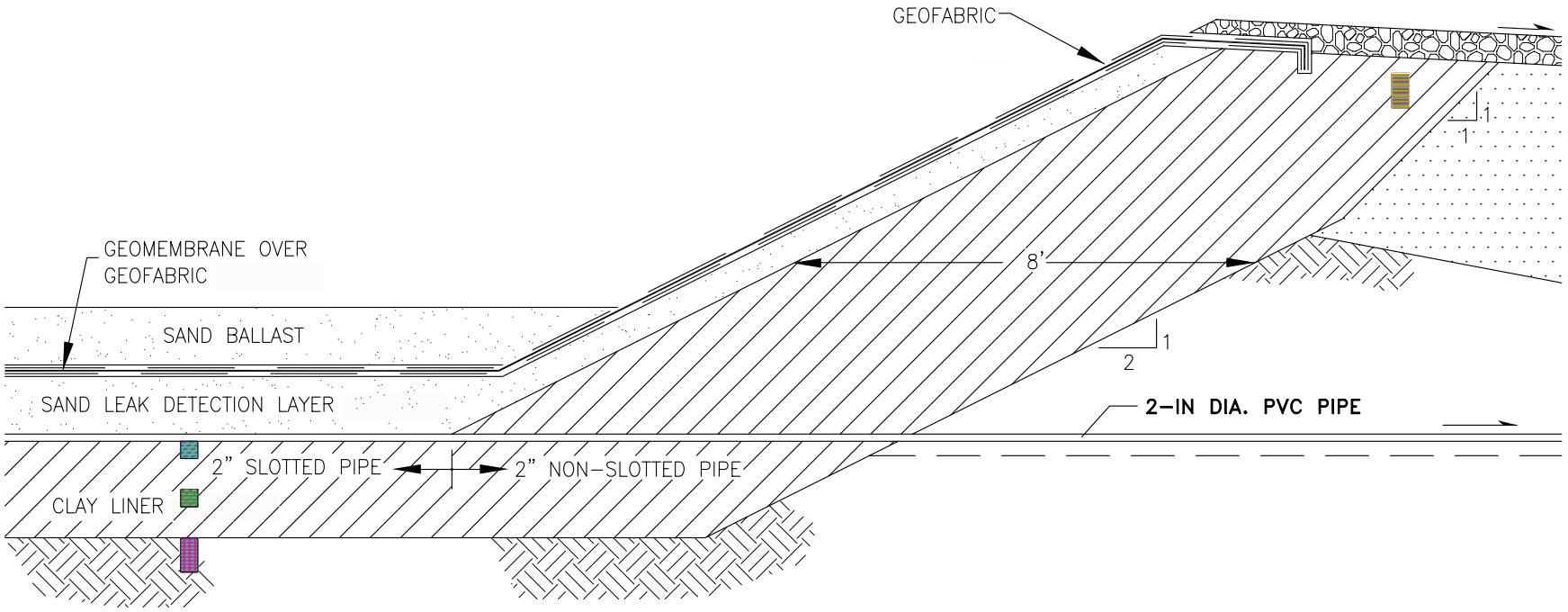
FIGURE **B-1**

PROPOSED VERIFICATION AND BACKGROUND SAMPLING LOCATIONS

LLNL/SITE 300 CLOSURE/CA

DWG ID: jraub | N:\Projects\043-7408 (LLNL-Site 300 closure)\Closure Plan\S&A Plan\Final SA Plan 2-03-05\Fig B-1 - Sampling locations.dwg | 2-22-5 15:40 | xrf: LLNL Ponds-Civil Plans

Golder Associates



TYPICAL LINER SECTION SCHEMATIC

NOT TO SCALE

LEGEND:

- 0-6" CLAY SAMPLE
- 12-18" CLAY SAMPLE
- 0-12" SUBGRADE SAMPLE
- BACKGROUND SAMPLE

FIGURE **B-2**

LINER SECTION SCHEMATIC

LLNL/SITE 300 CLOSURE/CA

APPENDIX C

PROJECT PHOTOGRAPHS

Photo 1: Lower Impoundment with berm soil placed to absorb remaining liquids for off haul.

Photo 2: Berm soil being mixed with free liquids in Lower Impoundment.

FIGURE **C-1**

PROJECT PHOTOGRAPHS

CLEAN CLOSURE PROJECT, SITE 300, LAWRENCE LIVERMORE NATIONAL LABORATORY

Photo 3: Excavation of soils and geomembrane from Lower Impoundment. Breached levee of Upper Impoundment in foreground.

Photo 4: Excavating stockpile of geomembrane and soils for load out from Upper Impoundment.

FIGURE **C-2**

PROJECT PHOTOGRAPHS

CLEAN CLOSURE PROJECT, SITE 300, LAWRENCE LIVERMORE NATIONAL LABORATORY

Photo 5: Loading of transfer trailer with geomembrane for off haul and disposal from Upper Impoundment.

Photo 6: View of Upper Impoundment following removal of geomembrane.

FIGURE **C-3**

PROJECT PHOTOGRAPHS

CLEAN CLOSURE PROJECT, SITE 300, LAWRENCE LIVERMORE NATIONAL LABORATORY

Photo 7: View from Lower Impoundment looking west (toward Upper Impoundment) following removal of geomembrane.

Photo 8: Excavating test pit for soil sampling in Upper Impoundment.

FIGURE **C-4**

PROJECT PHOTOGRAPHS

CLEAN CLOSURE PROJECT, SITE 300, LAWRENCE LIVERMORE NATIONAL LABORATORY

Photo 9: Excavating test pit for soil sampling in Upper Impoundment.

Photo 10: Test pit for sampling location adjacent to geomembrane and sand ballast stockpile in Upper Impoundment.

FIGURE **C-5**

PROJECT PHOTOGRAPHS

CLEAN CLOSURE PROJECT, SITE 300, LAWRENCE LIVERMORE NATIONAL LABORATORY

Photo 11: Typical sampling of clay liner from ~12” depth in Upper Impoundment.

Photo 12: Typical exposure of clay liner over native soils in Upper Impoundment.

FIGURE **C-6**

PROJECT PHOTOGRAPHS

CLEAN CLOSURE PROJECT, SITE 300, LAWRENCE LIVERMORE NATIONAL LABORATORY